



December Anniversaries

December 17, 1903

The Wright brothers piloted the first manned, powered, controlled flights of a heavier-than-air craft.

December 21-27, 1968

William A. Anders, Frank Borman and James A. Lovell, Jr., rode Apollo 8 to the Moon, the first men to go beyond the recall of Earth's gravity. Human-kind was no longer planet-bound.

From the first low-orbit flights, astronauts have tried to express the profound impact of seeing Earth whole. Anders wrote: *The Earth looked so tiny in the heavens that there were times during the Apollo 8 mission when I had trouble finding it. Imagine yourself in a darkened room with only one clearly visible object, a small blue-green sphere, then you can begin to grasp what the Earth looks like from space. As this was the holiday season, I was reminded of a Christmas tree ornament. I think that all of us subconsciously think that the Earth is flat, or at least almost infinite. Let me assure you that, rather than a massive giant, it should be thought of as a fragile Christmas-tree ball which should be handled with considerable care.*

The new sense of Earth as a peculiarly wonderful planet has been reinforced by other astronauts' photographs and by the recent view at the left. It is the first to show Earth and its Moon together, and was made by a camera aboard Voyager 1 when the craft was about 11.66 million kilometers away on its course toward Jupiter.

Managing Earth "with considerable care" requires timely, global information. Now, when needed, sources of such information are at hand. (Story, Pages 6-11)

Of billions upon billions of likely planets, is this the only one where life occurs? (Story on the search for extraterrestrial intelligence, Pages 3-4)

Now that it is possible to travel and work in regions far overhead, how will the space frontier be used? (Story in the next issue of *Air & Space*)

SCAN

For brevity, the National Air and Space Museum is usually referred to, in these pages, as NASM.

The September issue of *Air & Space* offered basic information about the first flights of 1903. Here, on Pages 12 and 13, is a quick look at what happened next. How did aviation as an industry get underway? Slowly, with infuriating frustrations, according to the eminent British historian Charles H. Gibbs-Smith who is spending a year at NASM as Lindbergh Professor, the first to occupy the Lindbergh Chair in history.

Professor Gibbs-Smith will join NASM's historian emeritus Paul E. Garber and three other exceptionally well-informed speakers at NASM's commemorative symposium December 14. The texts of the speeches will be published on that date under the title *The Wright Brothers: Heirs of Prometheus*. The volume is edited by Dr. Richard P. Hallion, a NASM Curator of Science and Technology. The book is 8 by 10 inches, with 224 pages, and 80 historic illustrations, and may be ordered from the Smithsonian Institution Press, P.O. Box 1579, Washington, DC 20013, \$5.95 paperback, \$15 hard cover.

The American Society for Aerospace Education plans its First National Aerospace Education Convention April 16-22, 1979, at the National 4-H complex near Chevy Chase, Maryland. One evening event is scheduled at NASM. For information, write to ASAE, 821 15th St. NW, Washington, DC 20005.

Copies of the ASAE's *Book of Aerospace Education* are available at the address above. This is a volume of reprints from four years' issues of the monthly *Journal of Aerospace Education* sent to ASAE members, and is a paperback of 304 pages with 300 illustrations. Articles are grouped for elementary, secondary and higher levels. \$9.95 (\$7.95 to members).

TO FIRST TIME READERS

Many copies of this issue are going to educators and librarians who do not expect it, as a one-time introduction; such readers who want to be on the permanent mailing list need to clip or copy the form on Page 15; mail to the address on the back cover. There is no charge. Pages may be photocopied for educational use. READERS WHO HAVE ALREADY SENT A CARD OR FORM DO NOT NEED TO RE-REGISTER.

Briefing

Melvin B. Zisfein
Acting Director, NASM



At the conclusion of my last "Briefing" column I promised that I would tell you about some of our new efforts beyond the exhibits program. For instance, our publications program is increasing in output. We have just issued the first of a new series, *Famous Aircraft of the National Air and Space Museum*, which presents the history of the service life and subsequent restoration of Excalibur III, a famous P-51 Mustang.* The next volume in this series will be *The Aeronca C-2: The Story of the Flying Bathtub*. Future volumes now in work will deal with the Messerschmitt Me-262, the Lockheed XP-80, and the Albatross DVa.

Meanwhile, our original series, *Smithsonian Institution Studies in Air and Space*, continues with publication scheduled this fall of *U.S. Women Flyers, 1910-1918*, and next spring of *Great People of Flight Technology*. This series is available through the Government Printing Office.

Our airplane and artifact restoration program is now planned and scheduled for the next five years: 1978 should yield restorations of the Lockheed XP-80, the Albatross DVa, the Curtiss Headless Pusher, and the Bleriot XI. Our efforts of 1979 are scheduled to yield restorations of the Piasecki PV-2, the Messerschmitt Me 262, and the fascinating Langley Aerodrome.

With the addition to our staff of a chief for our Education Division, we are beginning the build-up of that division and the implementation of a number of programs that we've been itching to get to. We're developing a center for live demonstrations so that we can present to our visitors those concepts of flight which can't be gained easily from the traditional exhibit format. We plan to increase our educational outreach through a variety of student and teacher programs and symposia. This will enable us to "transfer" the Museum from its physical base in Washington into classrooms around the country.

Programs emphasizing the needs of the handicapped and multicultural needs in museums are being refined, and these results will be made available to other museums and school districts.

In addition, all of our normal school and public tour services, the publication of this magazine, and the development of curricular materials will continue in high gear.

Our new big-screen film, "Planet," is in production as the successor of "To Fly." As our friends in show business might say, "That's a tough act to follow" and we all have our fingers crossed. "Planet" is scheduled to be premiered near the end of 1978, and its producer and his staff have been working on a literally worldwide basis to make a superb film. A note of gossip: While filming "Planet," an over-zealous helicopter pilot in India got the production crew in trouble by flying too close to the Taj Mahal on a trial run. So, much to their regret, they were prohibited from filming this magnificent building from the air. Our producers assure us that, this setback notwithstanding, they are producing a film of which we and they will be proud.

* *Excalibur III* may be ordered from the Smithsonian Institution Press, P.O. Box 1579, Washington, DC 20013, \$4.95.

Picture yourself on a hilltop away from city lights. The night is still, the air is cool. No clouds conceal the wondrous beauty of the starry darkness. The Milky Way splits the sky, reminding you of your citizenry in the spiral city of stars.

Why does it matter that we see the stars and know what astronomers spend their lives discovering . . . that Earth is only one of a fleet of planets orbiting a small star in a planetary system toward the edge of the Milky Way Galaxy . . . that there could be 200 billion stars in this Galaxy alone . . . that approximately one-fourth of all stars are similar to the one which bathes Earth with life-supporting energy. Current ideas of the origin of the Solar System suggest that similar planetary systems might be very common.

The chemistry of the universe seems to be relatively uniform. Reason suggests a consistent picture of how the chemical elements are manufactured in stars, spread through space and gathered into new stars, minerals and living cells, even our own. This leads us to specu-

late that what we find here on Earth may not be unusual.

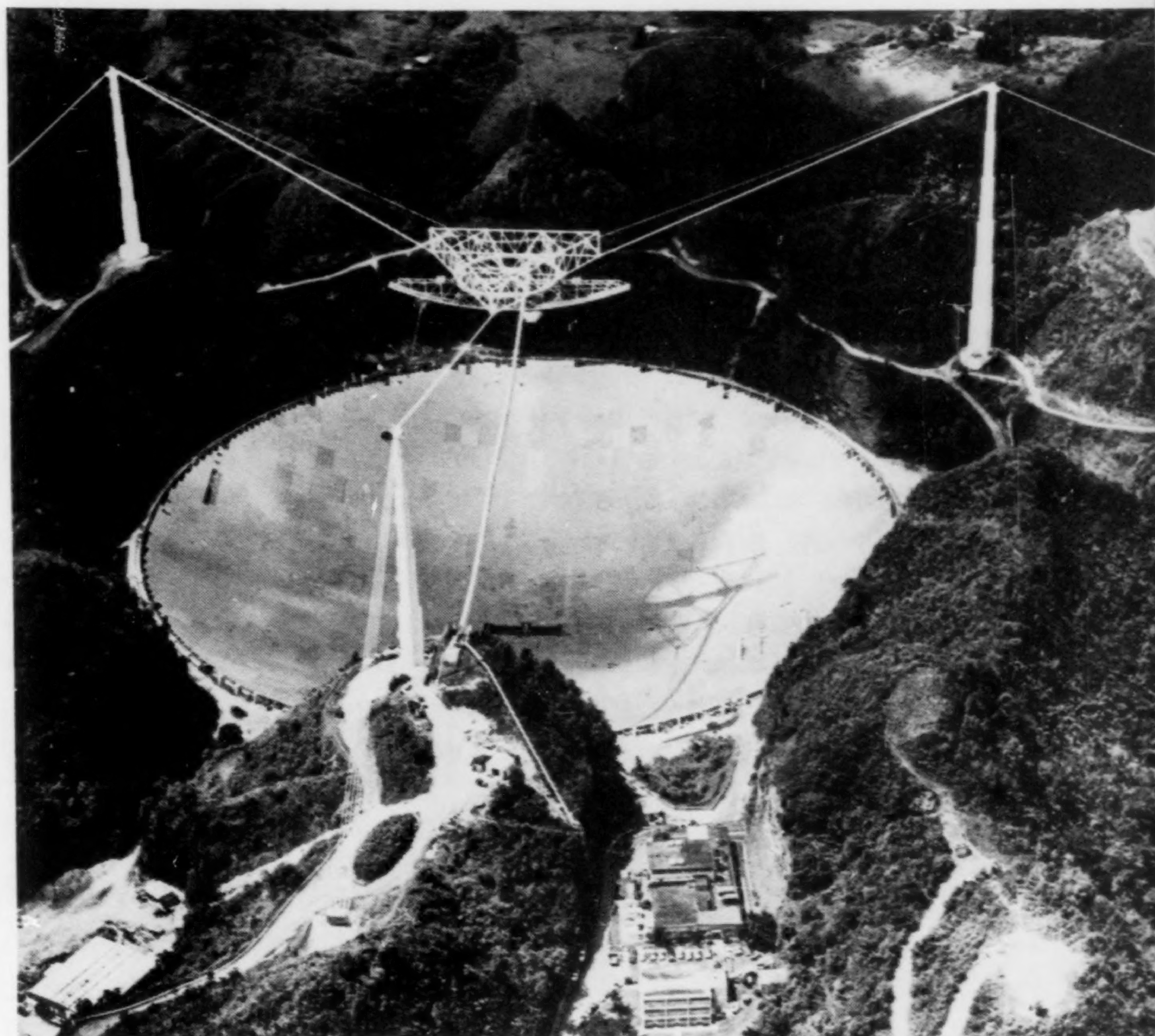
One by one, we have laid aside beliefs which placed us at the center of everything. We begin to believe that we are one example of expressions of the universe capable of studying the universe. We have not yet discovered other examples, but then we have just arrived at the state of technical development which makes it feasible to search.

Von Del Chamberlain
Astronomer, and Chief, NASM Presentations Division

No longer
called "crackpot"

The Search for Extraterrestrial Intelligence (SETI)

gives teachers a theme
for challenging assumptions
and developing imagination



The 300-meter (1,000 ft) diameter radio/radar antenna at Arecibo, Puerto Rico, would be able to communicate with another identical instrument as far as tens of thousands of light years away. A little of its time is now used for ETI searches.

"Either mankind is alone in the galaxy—or he is not; either alternative is mind-boggling."

Dr. Lee Dubridge
President, California Institute
of Technology, 1946-1969

The capacity to send out spacecraft has made it possible to look for life in nearby places. Nothing appears alive on Sun-baked Mercury, in the heat-oven of Venus, or on the airless Moon. The two Viking spacecraft that landed on Mars carried miniature biological laboratories which ran experiments with surface material dug up and deposited inside by a retractable

arm. The results are baffling. When Earth-type nutrients were added, some activity released oxygen. Other tests showed no evidence of organic molecules. Chemical, not biological explanations seem to satisfy most scientists. This experience is rousing acute interest in another mission to Mars which can fly a sample of the surface back to Earth or to an Earth-orbiting laboratory.

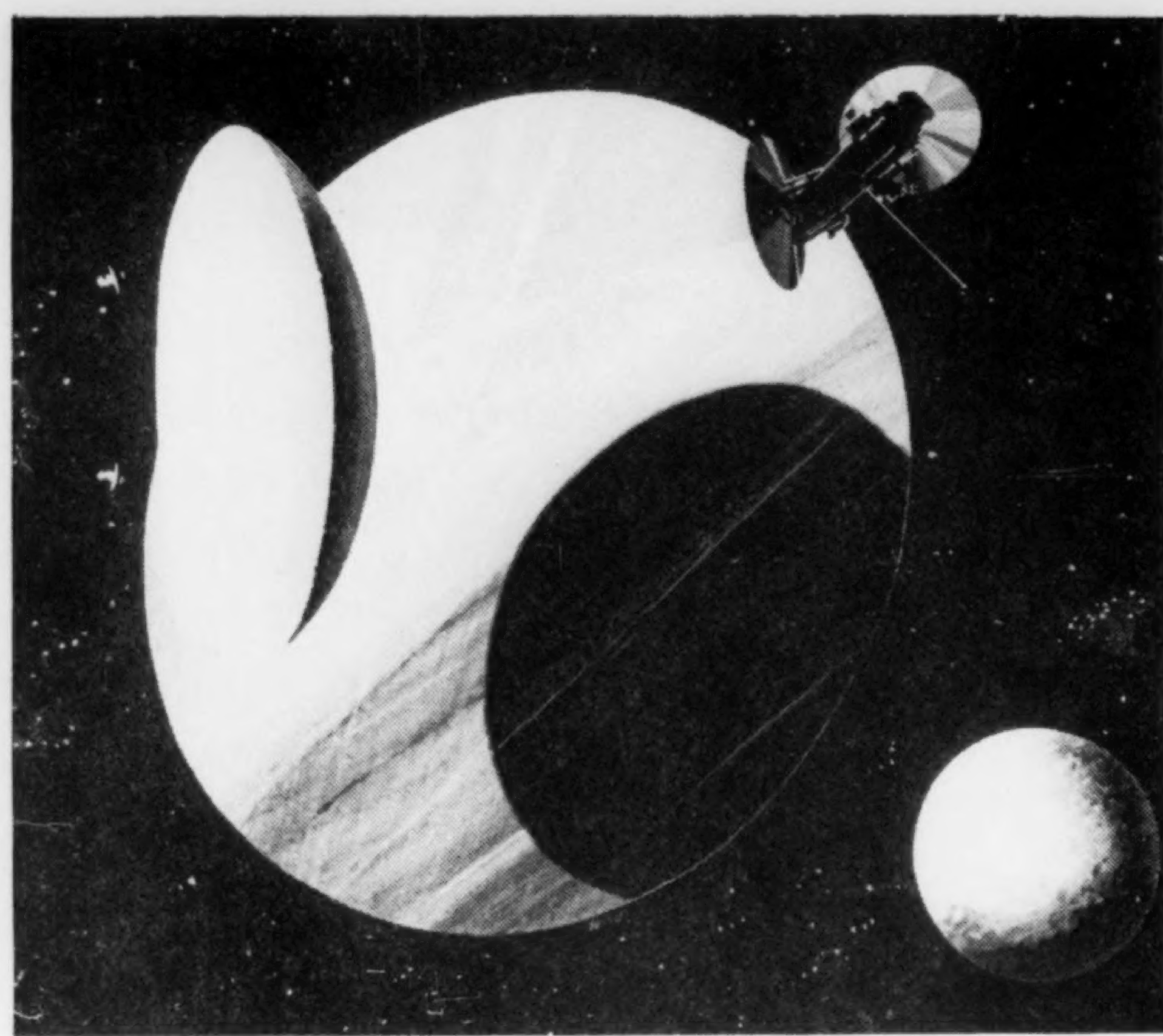
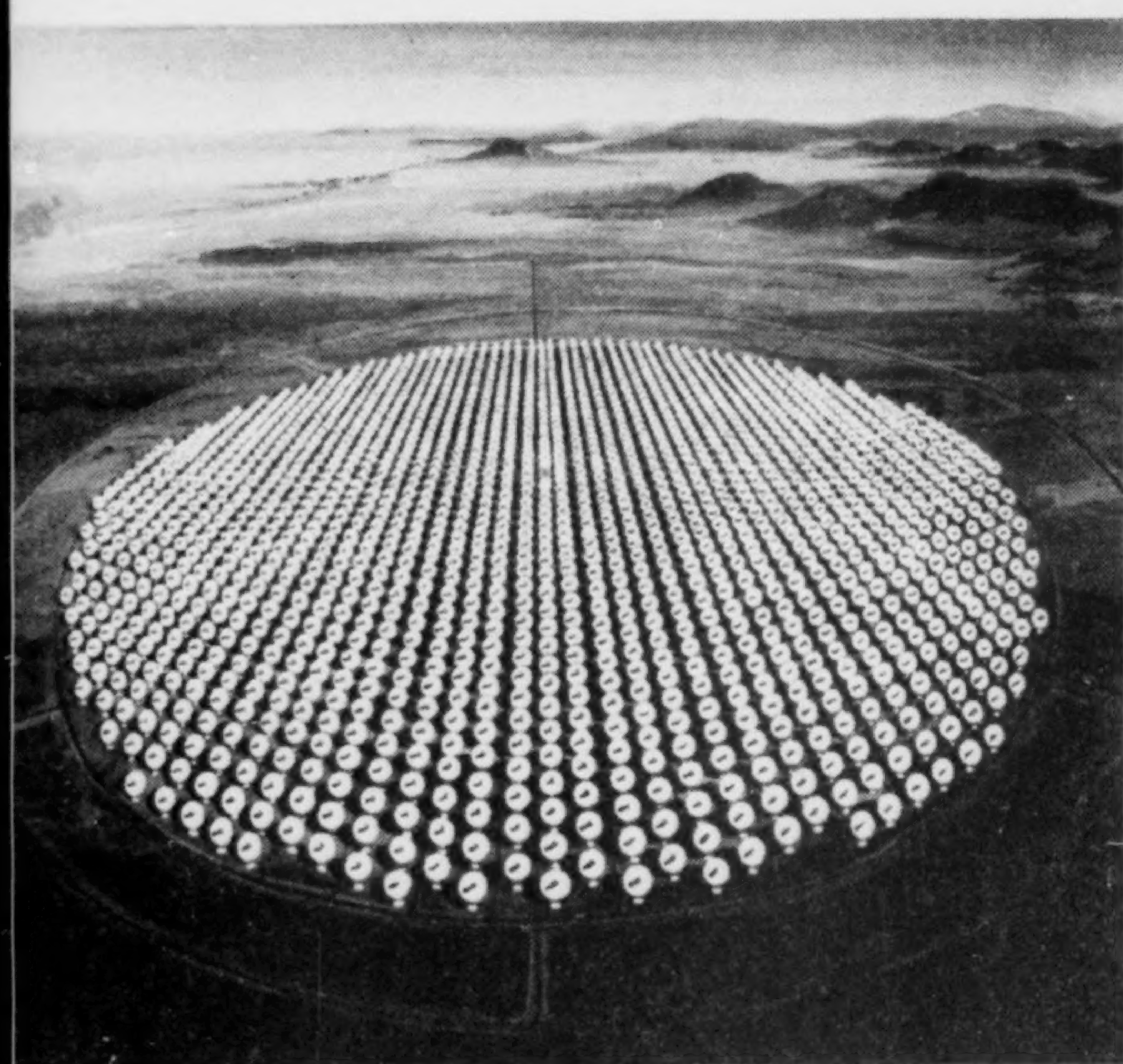
The next focus is on the clouds of Jupiter and one of Saturn's moons, Titan, which has an atmosphere. The Voyager spacecraft now on their way to the outer planets may return relevant information during the next few years.

The search which is abbreviated and

pronounced SETI ("set-ee"), however, looks much farther afield, in the hope of discovering civilizations elsewhere in the galaxy. As noted in the Outreach column, Page 11, the idea is winning scientific acceptance. There are two reasons:

(1) Astronomical observations from above the atmosphere, in spacecraft, confirm that the universe is actually a violent place. New stars constantly form from whirling clouds of dust and gas. The process here, some 4.5 billion years ago, included the agglomeration of planets, this Solar System. The process may be common. Most of the stars in the sky may be accompanied by

Continued on next page



Artists' concepts of two methods proposed in SETI: L., an Earth-based array of radio telescopes; R., one large antenna in space, shielded against Earth's broadcasting.

Continued from preceding page

planets currently undetectable from here, and the figure is "astronomical," billions upon billions.

(2) The molecules basic to Earth-life have been sparked into existence in laboratories by applying electrical energy (equivalent to a lightning bolt) or ultraviolet radiation to a few chemicals which were plentiful in Earth's early years. The same basic chemicals are available everywhere (those listed in the Table of Elements). If one applies the mathematics of probability, the answer is an overwhelming probability that self-replicating molecules have arisen elsewhere. Organic molecules have been found in meteorites and detected in interstellar space. Since intelligence has survival value, could organisms on other planets have followed their own special pathways to civilization—and technology?

Scientists who have analyzed the prospects believe that the best way to start probing the Galaxy for life is to listen for electromagnetic signals, for some pattern different from the natural radiations of the universe.

The speed of light is considered the ultimate possible speed. Communications could therefore be a slow process. The closest star, actually a triple star system, Alpha Centauri, is 4.2 light

years away. That means that 8.4 years would elapse between the sending of a question and receipt of an answer. There would be a far longer gap in reaching more distant stars. But any message received or intercepted would say that intelligence has existed, and Earthlife is not alone.

Most of those working on SETI develop a conviction that other civilizations would be far in advance of Earth's. They mention the "improbable" chance of accidental communication with interstellar travelers from such technologically superior societies.

Dr. Joels and Dr. John Billingham, the SETI program director at NASA's Ames Research Center wrote: "There would likely be profound lessons in science and technology for us to learn . . . totally new forms of art, philosophy, values and social systems. We have been able to transmit and receive signals across galactic distances only for about 10 years. We would be the newborn of an interstellar communicative network, if it exists." *

* "The Search for Extraterrestrial Intelligence," by John Billingham and Kerry Joels, a 4-page reprint from the Journal of Aerospace Education, November 1976; color illus., free from the Society for Aerospace Education, 821 15th St. NW, Washington, DC 20005.

In having students think about other life, teachers can bring out the many unconscious assumptions held by Earth's species. Why should life be associated with a surface? Could life exist in clouds, in space?

Could there be other senses? Other adaptations to different temperature ranges, different pressures, different atmospheres and radiations? Life here follows only one pattern: Carbon-based, with a DNA-replicating system. What about silicon-based life? Background for such discussions is in Chapter 6, "Chauvinism," of Dr. Carl Sagan's book named below, among other substantial readings on SETI.

The Cosmic Connection: An Extraterrestrial Perspective, Carl Sagan, paperback, 274 pp., illus., index. Dell Publishing Co., New York, 1973, \$1.75.

The Search for Extraterrestrial Intelligence, by participants in a 1975 conference, paperback, 276 pp., illus. NASA SP-419, 1977, Government Printing Office, Washington, DC 20402, correct Stock No. 033-000-00696-9, \$4.50.

The Possibility of Intelligent Life Elsewhere in the Universe. Report by the Library of Congress for the Committee on Science and Technology, U.S. House of Representatives, November 1975. Paperback, 6 by 9 in., 76 pp., Government Printing Office, Washington, DC 20402, \$1.10.

Fact Sheet on SETI, about the seven-year program started in October, to listen for signals via NASA's Deep Space Network and special equipment; 6 pp., Office of Public Information, Bldg. 180, Room 200, Jet Propulsion Laboratory, Pasadena, California 91103. Free.



© Henry Caruso

New 15-Minute Aviation Weather Telecast

An unusually informative weather report for aviation interests will be aired over public television stations beginning October 30, 6:45-7:00 a.m., weekdays. It is sponsored by the Federal Aviation Administration and the Air Safety Foundation of the Aircraft Owners and Pilots Association, and is produced by the Maryland Center for Public Broadcasting in cooperation with the National Weather Service.

With more time than the usual three-minute weather forecast, this program can include a greater range and depth of information about meteorology, and will use more images of the entire U.S. from weather satellites.

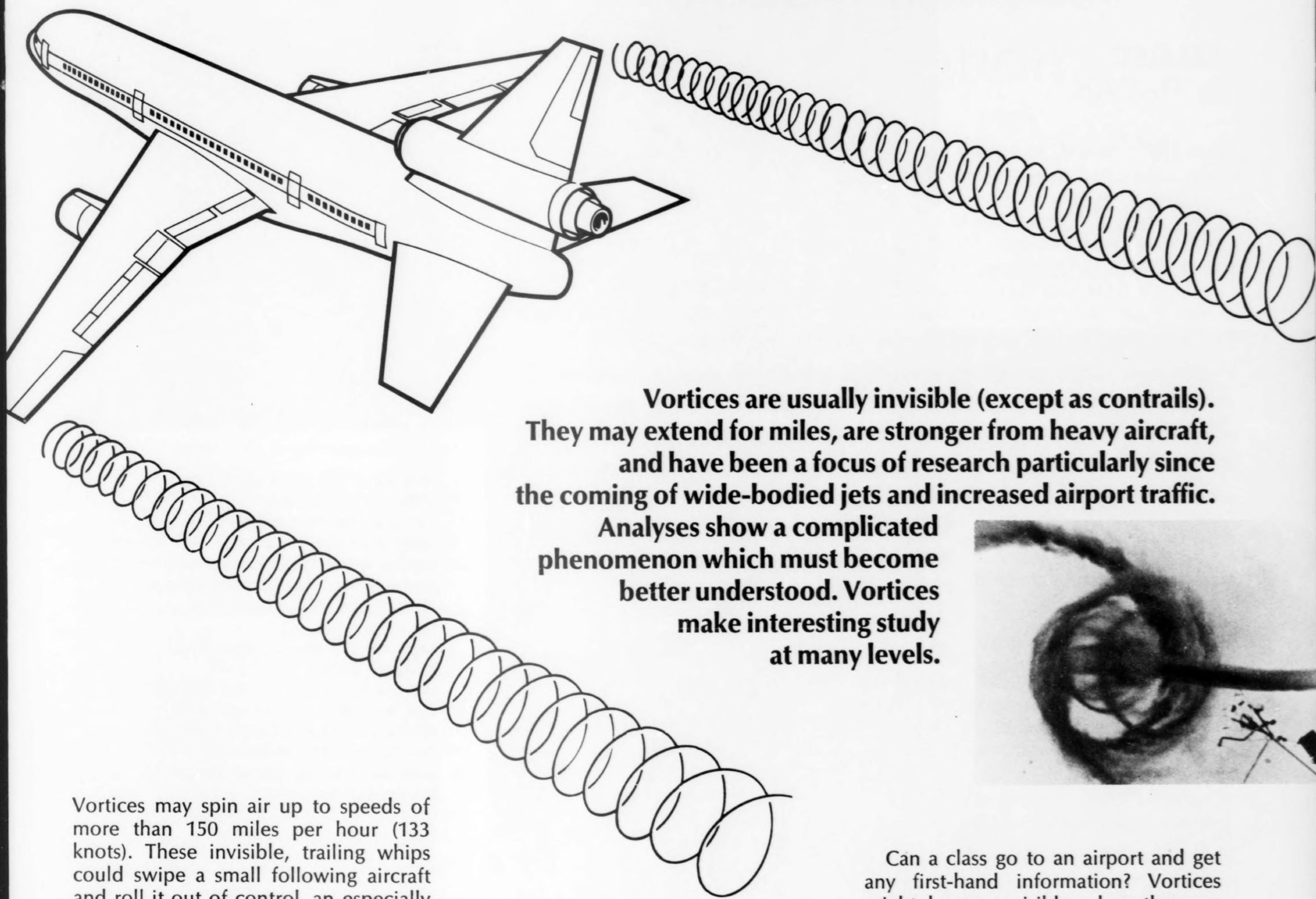
According to Ed Gross, Aviation Branch, National Weather Service, the show is not only a practical aid to pilots, supplementing FAA data, but also a laboratory to test new tech-

niques in visual weather reporting. Some programs are being prepared from viewpoints other than aviation, such as marine or agricultural. These shows will be ready to air on days when the weather is so good there's little to say about it.

Altogether, Mr. Gross believes, "the viewer will learn much more about weather, from a more sophisticated kind of show."

An aircraft wing produces lift by causing air to flow faster, therefore with less pressure, over the top. Near each wing tip, in flight, the higher pressure air from beneath curls up to mingle with the fast flow, and automatically forms a "horizontal tornado" called a

Wake Vortex



Vortices are usually invisible (except as contrails). They may extend for miles, are stronger from heavy aircraft, and have been a focus of research particularly since the coming of wide-bodied jets and increased airport traffic.

Analyses show a complicated phenomenon which must become better understood. Vortices make interesting study at many levels.



Vortices may spin air up to speeds of more than 150 miles per hour (133 knots). These invisible, trailing whips could swipe a small following aircraft and roll it out of control, an especially serious problem during landings and takeoffs when the pilot may be too close to the ground to recover.

Both the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA) are looking for solutions of many kinds—a change in the way wings are shaped, or a way to make the wings' vortices break up more quickly. Researchers continue to meet surprises in a complex phenomenon. Someone who is a student today may be the one who finally figures out what to do.

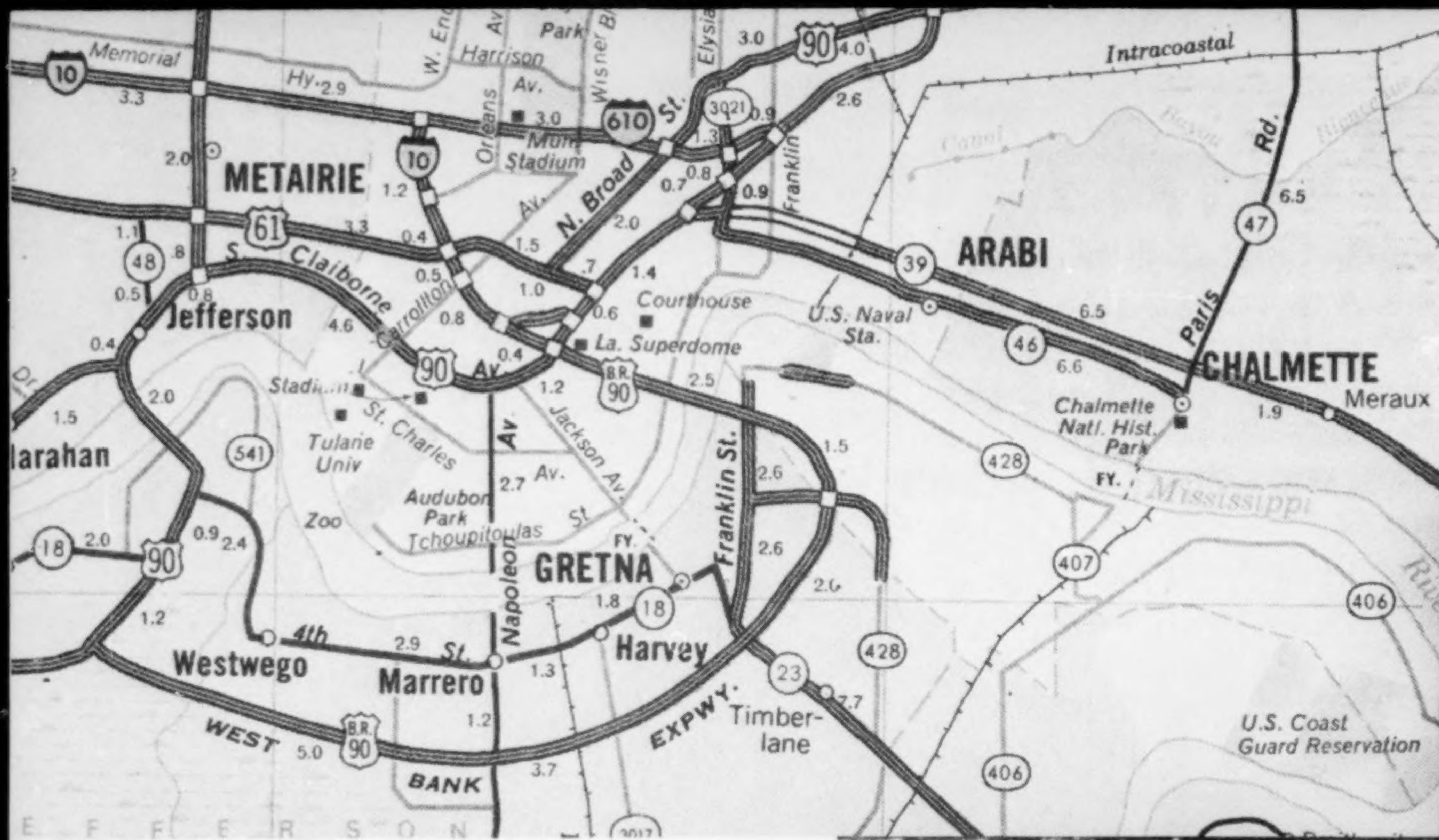
Meanwhile, air traffic controllers space their incoming and departing

aircraft so as to avoid the likelihood of any one of them running into an unseen vortex. The controllers' standards and careful pilots have kept vortex-related accidents low. Only a few of all aviation accidents have wake vortices attributed as a possible cause. But the FAA foresees traffic doubling in the next few years, at major airports, and increasing as much as five times by 1995. Planes will have to be zipped in and out of airfields with absolute knowledge or control of vortices.

Can a class go to an airport and get any first-hand information? Vortices might become visible when they are filled with the darker exhaust which comes from wing-mounted engines, like those of a 707 or a DC-8. Anyone near the touchdown or takeoff point of a runway can feel the swoosh of air. (More, back cover.)

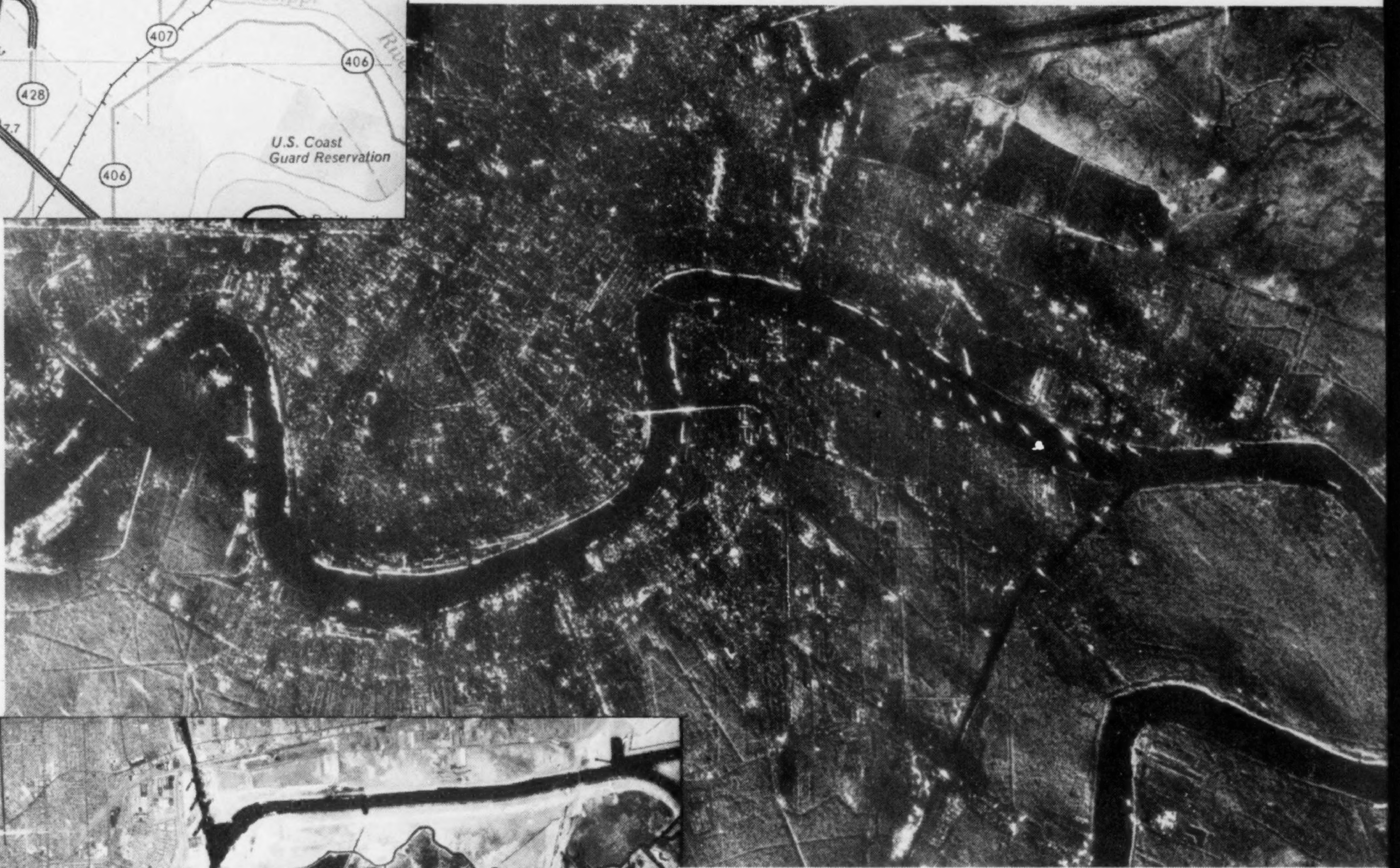
Technical but readable: *Aircraft Wake Vortices, A State-of-the-Art Review*, February 1977. (Some of the math is at high school level.) Report No. FAA-RD-77-23. Order from National Technical Information Service, Springfield, Virginia 22161, code ADA 042-442, \$12.

Aircraft Wake Vortices, An Annotated Bibliography, January 1976 (abstracts of 570 publications), Report No. FAA-RD-76-43. From NTIS, code ADA 023-415, \$11.75.



Remote Sensing of NEW ORLEANS, LOUISIANA

IMAGES
by RADAR,
right
by INFRARED
center
and by RED
REFLECTIONS
bottom

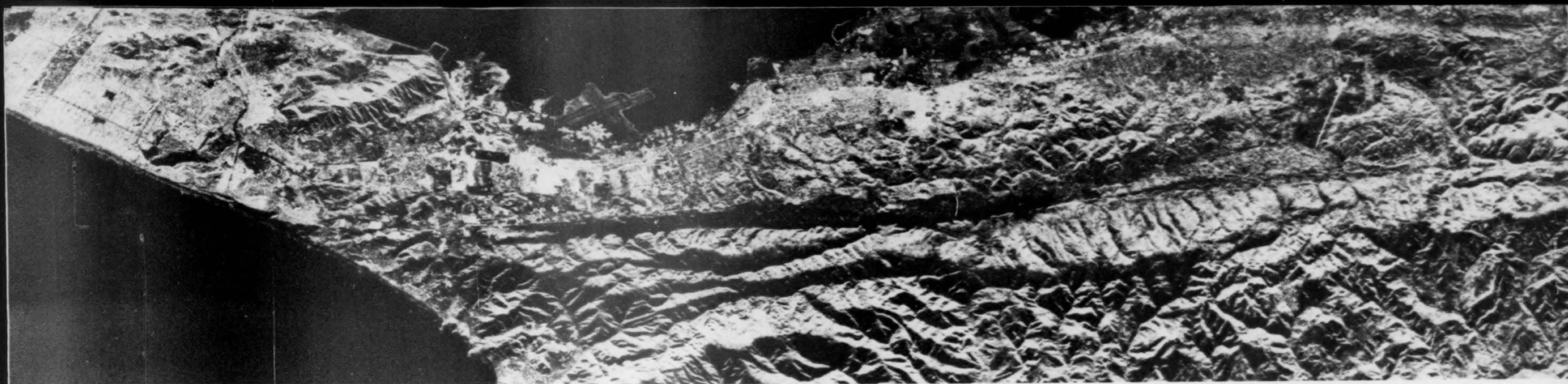


Images of the same terrain by
different techniques:

Top left, Rand McNally's
symbolism in a road map.
Above, a Goodyear Aerospace
image made by radar from an
aircraft; the Mississippi River
appears black.

Left, a NASA image made by an
airborne sensor of infrared
radiations invisible to the human
eye; waterways are sharp black.
Below, part of one Landsat image
from about 910 kilometers
altitude, made by one of the four
Multispectral Scanners, Band 5
(see Pages 8-9) red light only.
Now, water appears white.





Airborne radar produces vivid images of Earth, as in this view of the San Francisco peninsula showing San Andreas Fault.

R/S Opens New Era of Information

R/S—a common abbreviation of Remote Sensing—is the technique of using instruments which can secure information about physical phenomena from a distance, with permanent records.

For decades, cameras have been flown in aircraft. Now, electronic sensors "see" more than the human eye and return new information; those in spacecraft "see" on a new global scale. Electronic sensors work like TV; signals can be processed into a picture which resembles a photograph but is called an image.

Electronic eyes have two advantages: (1) They can be designed to respond to any of the wavelengths in the electromagnetic spectrum. Earth is reflecting or radiating many more wavelengths than those called light. Vegetation, for instance, reflects strongly and characteristically in the infrared. The satellites designed to survey Earth resources, the Landsats, carry Multispectral Scanners for four of the most informative reflected wavelengths and two of them are in the infrared. Others are for red and green light. Landsat 3 also senses heat radiated from the ground. (2) Electronic sensors telemeter data to Earth in a form which can be stored on

computer-compatible tape. And that is the secret of their success. "Data as it comes down is pretty useless," said one Landsat expert. It's what a computer can do with the data that produces such a range of useful information.

A computer can make light features lighter and dark ones darker, to enhance an image and sharpen detail. A computer can work out ratios among the sensed wavelengths and so tell an interpreter of an image which little streaks are roads, garbage dumps or strip mines. Images may be printed in an arbitrary choice of colors which act as a visual code to different elements.

Substitute ears overhead include receivers on many satellites which pick up beeps from instruments set out in wild and dangerous places to monitor environmental conditions. For instance, when tiltmeters in the throat of a volcano react to movement of the surface, their message is flashed via satellite to agencies which can issue warnings if necessary.

Radar is an electronic ear, in the sense that the system broadcasts microwaves and registers the pattern of the echo. Radar measures distance accurately, with the additional advantage of being able to work at night and through clouds.

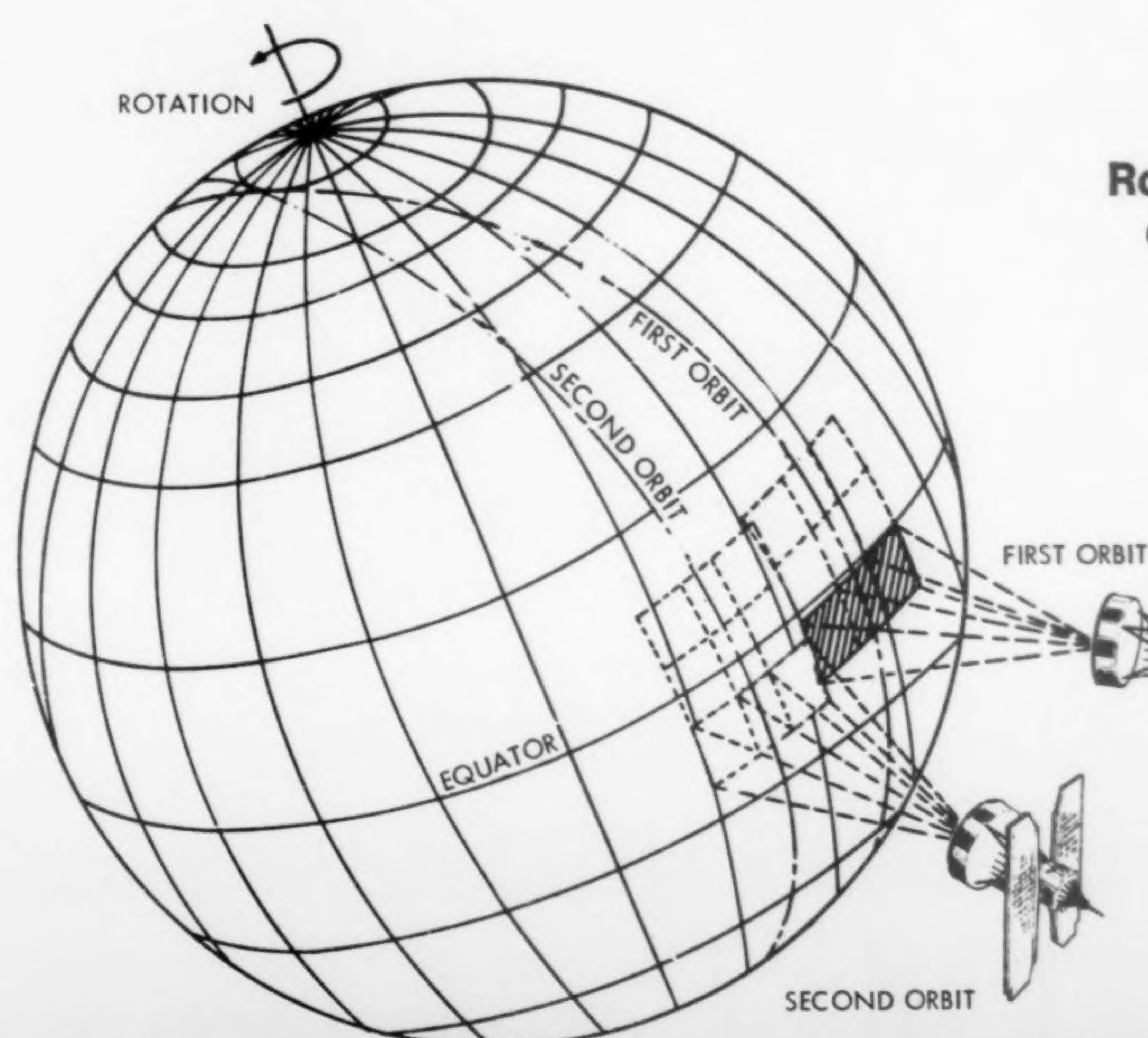
The value of high altitude, undis-

torted images of Earth for map making is obvious, because inaccessible regions are as easily imaged as one's hometown. Brazil recently secured the first maps of the Amazon basin, made through jungle foliage by Side-Looking Airborne Radar (SLAR).

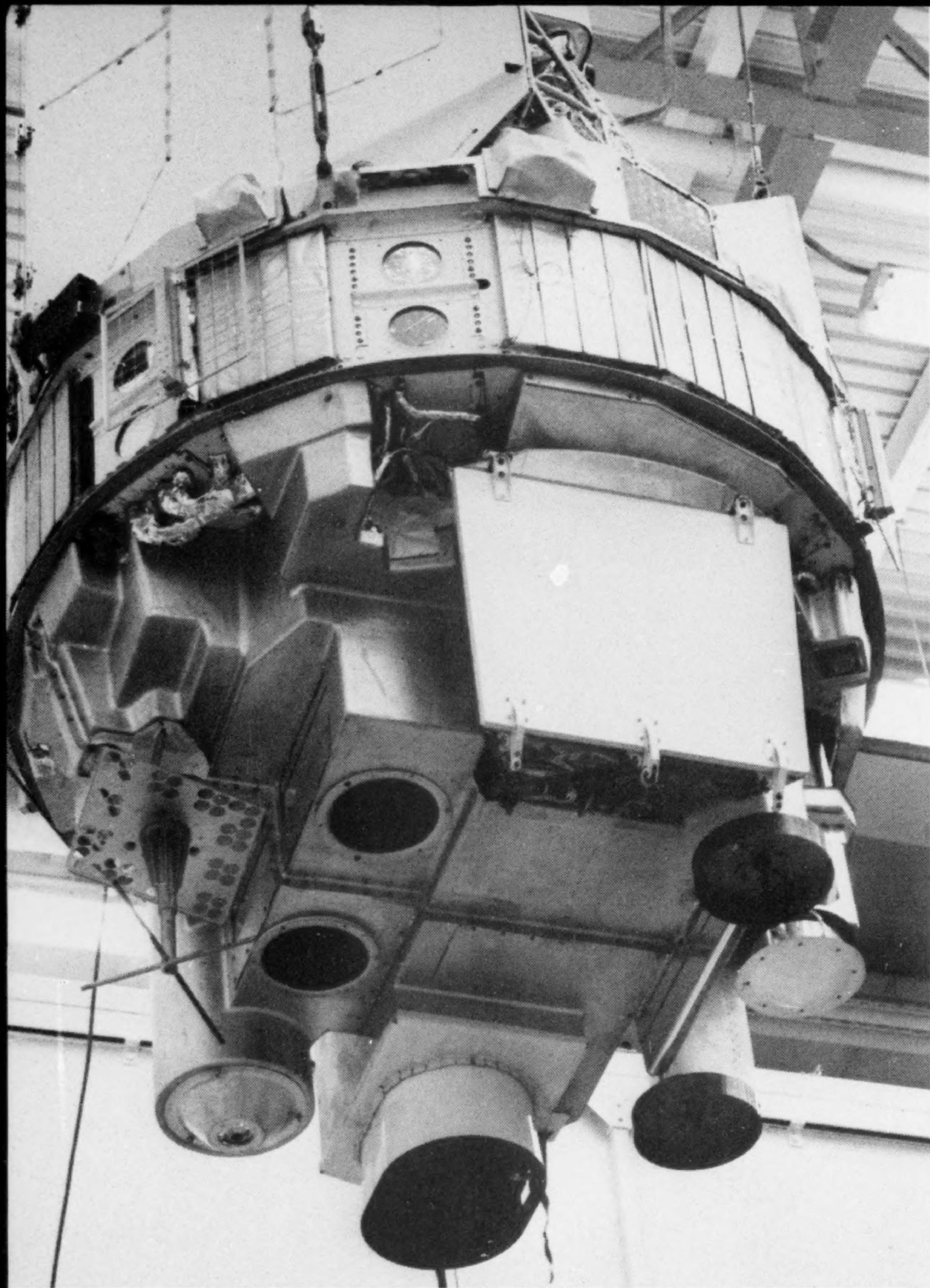
But even more valuable is the fact that dynamic processes on Earth's surface can now be followed as they develop. Each Landsat at 910 kilometers altitude returns an image of the same place every 18 days. The geosynchronous weather satellites at 35,000 kilometers altitude can be asked to send down their views of an entire hemisphere as often as every three minutes (as for tornado tracking).

Usually it's the geography teacher who arranges field trips for a class, comparing reality with maps, photographs and images. But many other studies make use of remotely sensed images, notably agriculture, forestry, pollution control, water resource management and economics. The World Bank routinely uses Landsat images in evaluations of proposals that concern land. Geologists scanning Earth for clues to untapped deposits of oil and gas find Landsat of significant value even though the sensors were planned primarily for agricultural work. Nearly 100 energy-related corporations recently formed The Geosat Committee. It has become an effective lobby urging that future spacecraft carry sensors of different wavelengths ideal for discriminating rock types.

Nearly 100 nations have cooperated with NASA on Landsat alone. Stations to receive, process and sell Landsat images are operating in other nations. Many developing countries learn about their natural resources for the first time from remotely sensed images, and see their place in larger ecological regions. Images from satellites are providing an objective basis for setting global priorities in matters of global environment and resources.



Rough indication of the way polar-orbiting satellites maintain a circular path while Earth rotates beneath, and the sensors "see" a different swath, to the west, on each revolution. Landsat's daily longitude shift at the equator is 1.43° or 159 km. Landsats circle Earth about 14 times daily and get global coverage between 81° latitude N and 81° S, in 251 revolutions (18 days). Then they start repeating the process.



3

3. Landsat 3's Earth-facing surface. On the circular collar vertical panels are temperature control louvres. The large panel is the cooler door for the thermal infrared band of the Multispectral Scanner (MSS); in space, the door opens. The two flush, dark apertures (left center) are the Return Beam Vidicon cameras. Three vertical cylinders on the right (two with dark ends) are antennas. The oval opening (bottom) is for the MSS. Left of it, the cylinder with a small central aperture is the sensor for maintaining Landsat's correct attitude toward Earth. Above it, small rods forming an X are the antenna picking up signals from environmental sensors on Earth, as for snow depth, stream flow, etc.

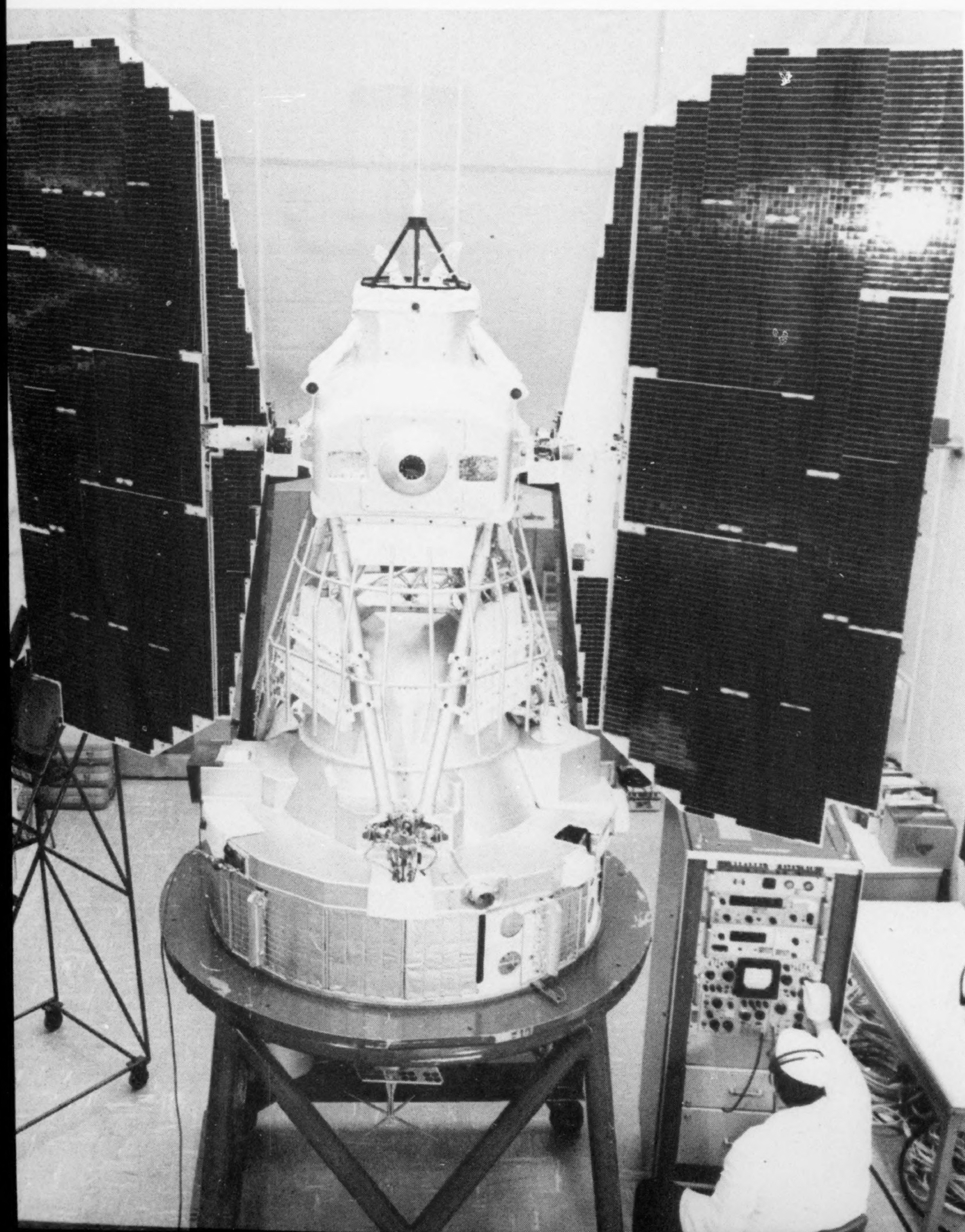


4

Thrust Augmentation Solids



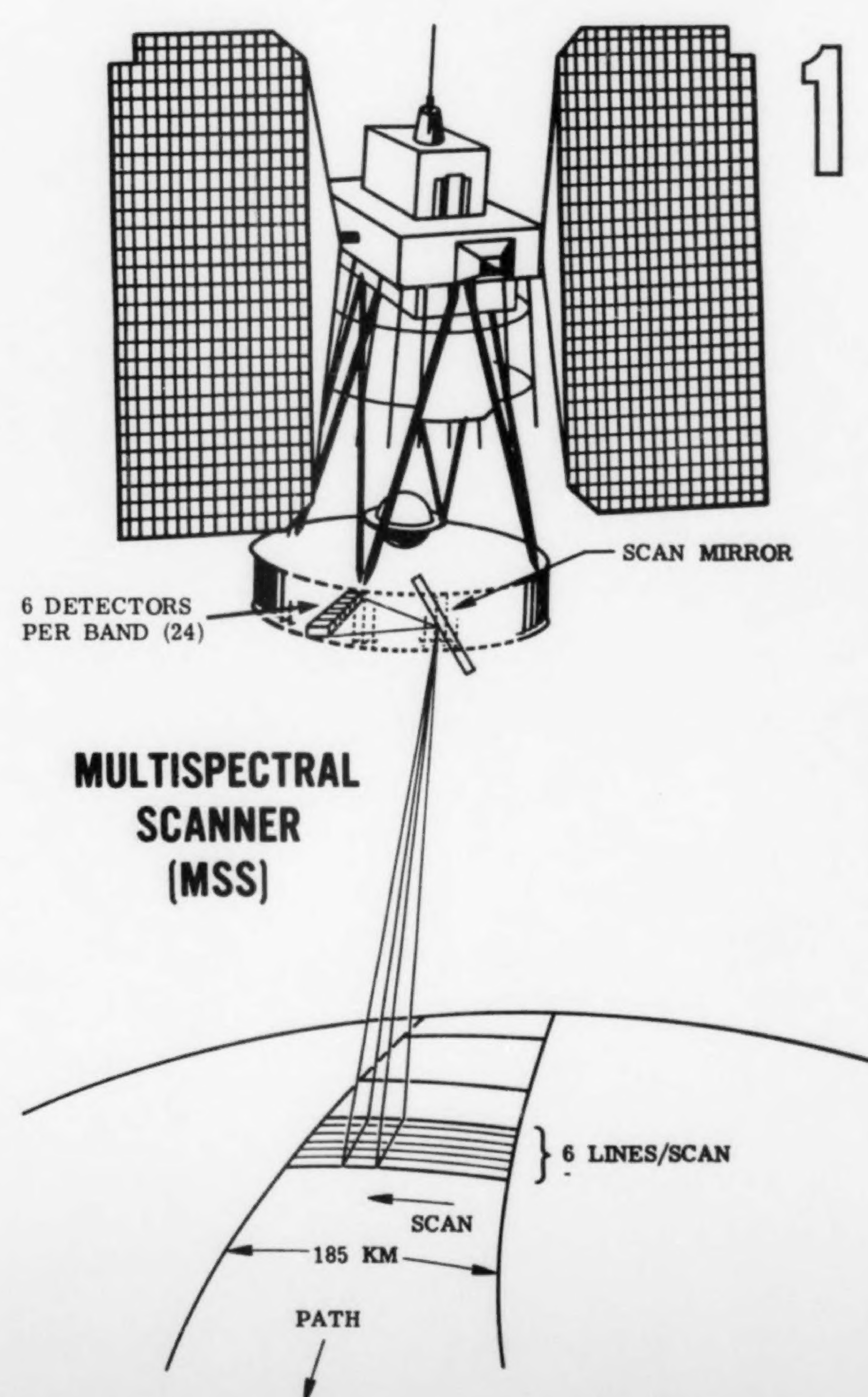
4. Landsat 3 lift-off, March 1978, from Vandenberg Air Force Base, California. The booster is a Delta with liquid propellant stages and solid propellant strap-on boosters.



2

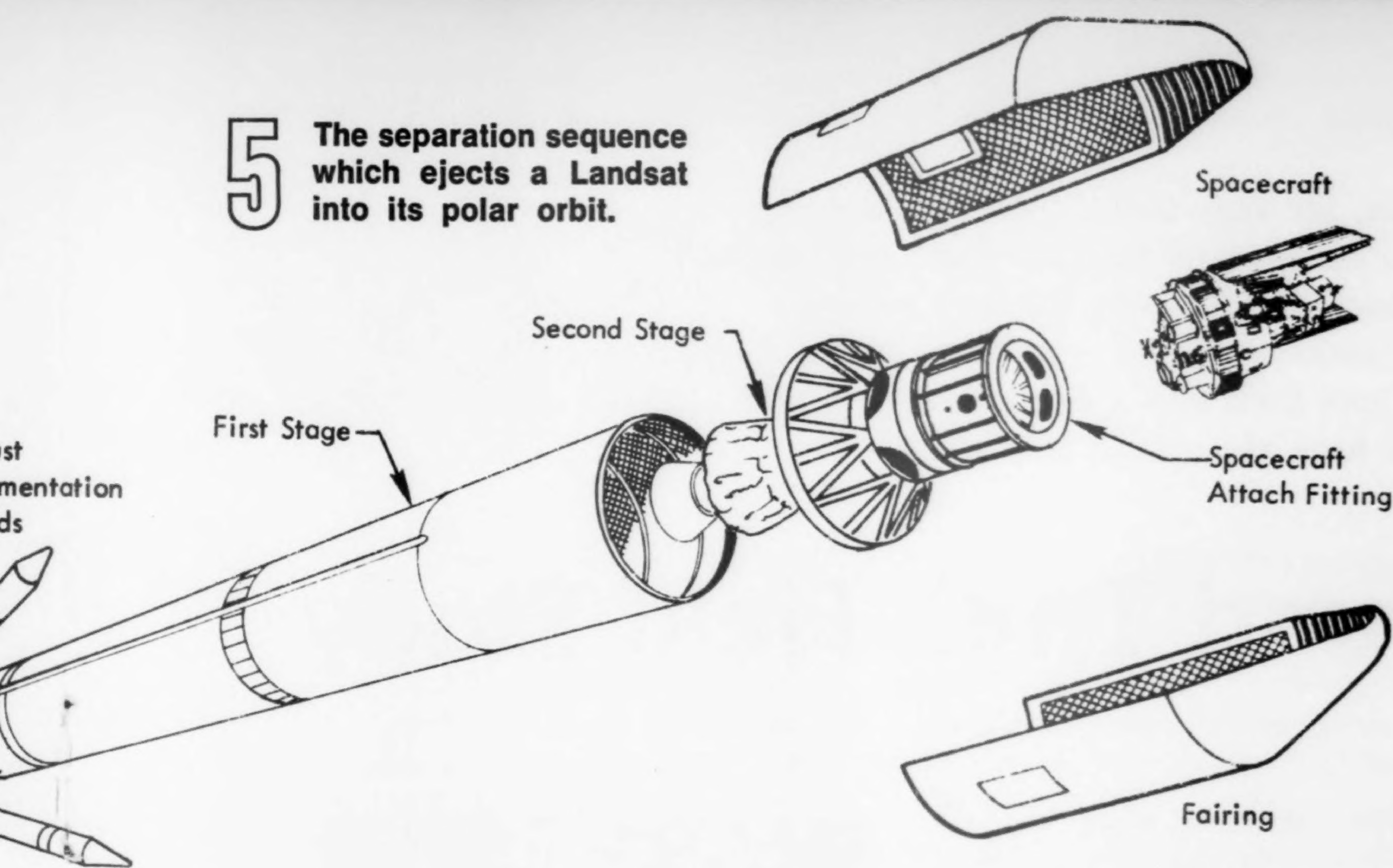
Reading clockwise from below: How a

1. Landsat's MSS (below) uses an oscillating mirror for continuous scanning, on command, of four wavelengths from 0.5 to 1.1 micrometers, and a thermal band 10.4 to 12.6 micrometers. Scene is 185 km square.
2. General Electric engineers test the two solar panels on Landsat 3.



5

The separation sequence which ejects a Landsat into its polar orbit.



Landsat-3 at
f, March 5,
from Van-
erg Air Force
California.
ter is a Thor-
with two
propellant
s and nine
propellant
on Castor-II
rs at bottom.

Landsat

Three have been launched: 1972, 1975, 1978. A fourth is planned for 1981. Until January, 1975, the first one was known as ERTS (Earth Resources Technology Satellite).

How a Landsat is planned, built, launched, operated, and used.

Photos 6, 7, 8, at the Landsat command, tracking and data handling center, Goddard Space Flight Center, Maryland. Photo 6: Missions Utilization Chief Dr. Stanley C. Freden points to the next orbital path on a plastic panel that slides in front of a world map. L. to R., Ron Gale, John Guida and Don Lampe plan and issue commands to the two Landsats. Photo 7: At the console, Robert Wynne can check the status of hundreds of functions on the satellites, and by phone, keep in touch with other U.S. tracking stations, in California and

Alaska. Harry Brown, center, is also an operations supervisor; John Tallman is an evaluator.

Photo 8: Robert Oertly, ground equipment supervisor, watches reception of MSS data as Dennis Bobb makes adjustments to secure the best quality recordings. All tracking offices are staffed 24 hours a day.

Photo 9, below: Louisiana officials, L. to R., Charles D'Agostino, Bradley Spicer and Eddie Schwertz, Jr., use Landsat images to map all areas inundated during recent Mississippi floods.

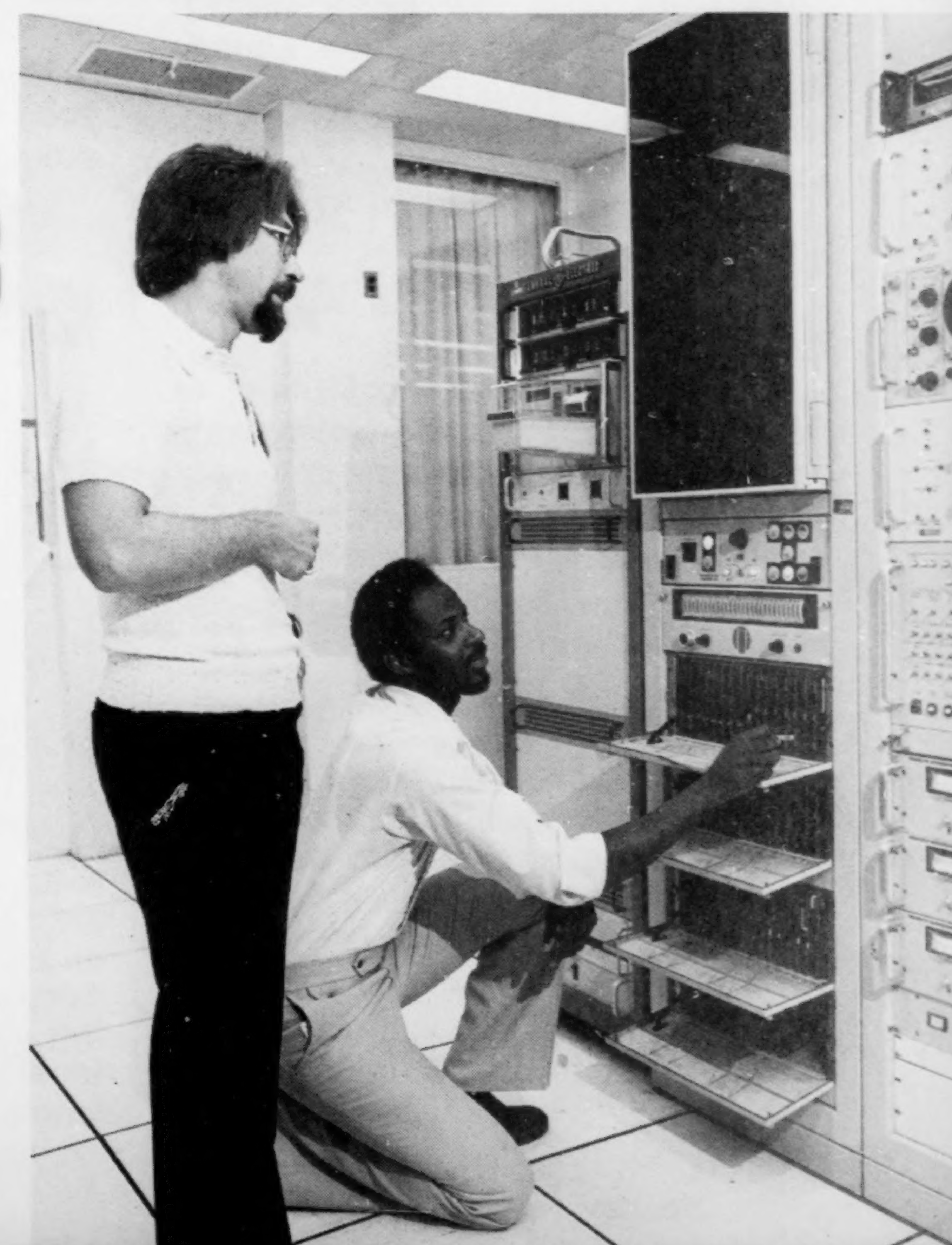
6



7



8



9



Remotely sensed images, as well as standard maps, are very useful tools for learning about the environment. If one is trying to teach students (any level, Grade 3 on) how to interpret spectral signatures in remote sensing, and how to apply them in solving environmental problems, the best way to get the students started is to take them out into the field where they can look at a familiar object, and then find it in the imagery, and see, on the spot, what its signature looks like. This look at the land is called

Ground Truth Field Study

By Dr. William H. Wake
Department of Physics and Earth Sciences
California State College, Bakersfield
(Past President, National Council
for Geographic Education)

The school yard is an excellent site for the students' first field experience because it and its neighborhood context are familiar. An elevated site such as a hill or even a second floor window opens a broader panorama and gives the students an overhead oblique view which provides a transition for them to the vertical view of imagery and maps.

It is exciting for students to identify their school and homes on large-scale imagery, and trace the routes they take from one to the other. The teacher can help them recognize and understand the elements of reading and interpretation of the familiar landscape to apply these elements to reading and interpreting unfamiliar landscapes. Subsequent trips to less familiar areas with different signature/symbol characteristics will broaden the affective and cognitive mastery of the students, and maintain interest by new challenges.

Once the field site is selected, learning materials kits can be assembled. Ideally, these will include:

- Oblique and vertical imagery, large scale from low flying aircraft; medium scale from medium altitude flights (as by NASA's U-2 and RB-57F); small scale from high altitude, Landsat imagery.

- Topographic maps at 1:24,000 and 1:250,000 scales.

- Thematic maps, road maps and three dimensional models.

If budgets prevent acquisition of such a set, the following will provide for limited but useful study:

- One low flying aircraft image, for local analysis.

- One Landsat image for multi-regional analysis.

- A 1:24,000 topographic map.

- A road map.

Magnifying glasses, protractors, rulers, and simple graphic planimeters as shown in the photograph to the right, enable students to make field measurements of direction, distance, scale and area. Clear acetate or tracing paper overlays allow imagery and maps to be reused, to produce land use and other problem maps.

It is not necessary to provide each student with a complete set of imagery. Indeed, it is preferable not to do so, especially in the lower grades, because of the value of teamwork to strengthen and speed up the learning processes by discussion and sharing of information, concept understanding and problem solutions. Teams of three to six are usually the most effective, especially if members are permitted to regroup according to shifting points of interest.

A set of specific problems will optimize the value of the field work. They may include feature identification, measurements, relationships, comparisons of information, signatures, and symbols at different scales, and updating. Students can thus find the parts (features), analyze and synthesize them into the total landscape, and solve problems related to their use.

The pre-field trip orientation is a good time to introduce the imagery, purpose of the trip, the elements of



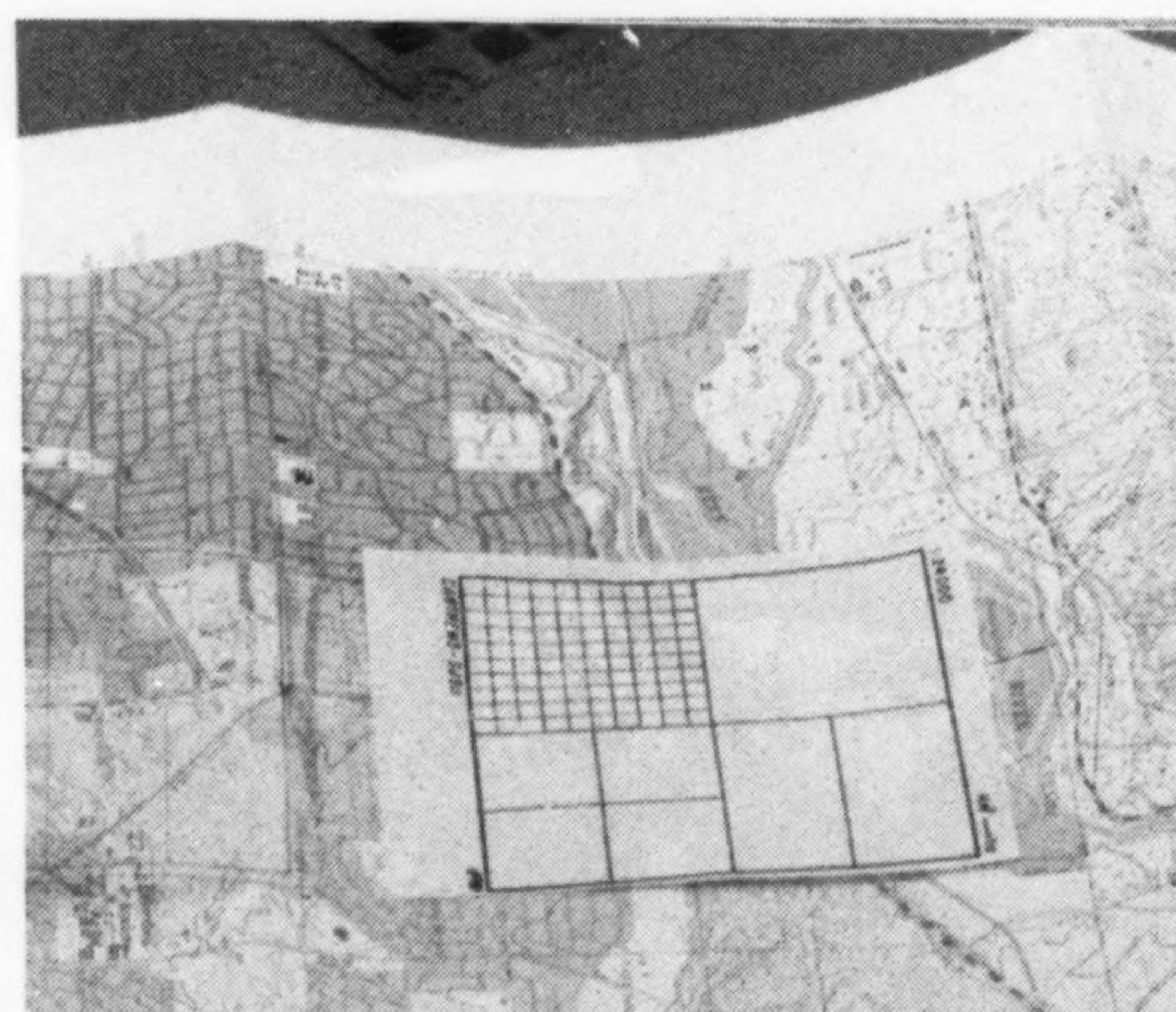
Velma Wallace on a remote sensing field trip with her fifth grade class from the Hort School, Bakersfield, California.

reading and interpretation and sample problems. The post-field trip laboratory session can best begin with a review discussion to reinforce old points and introduce new ones, then move to solution of more complex problems. The field and laboratory problems provide the basis for evaluation of learning.

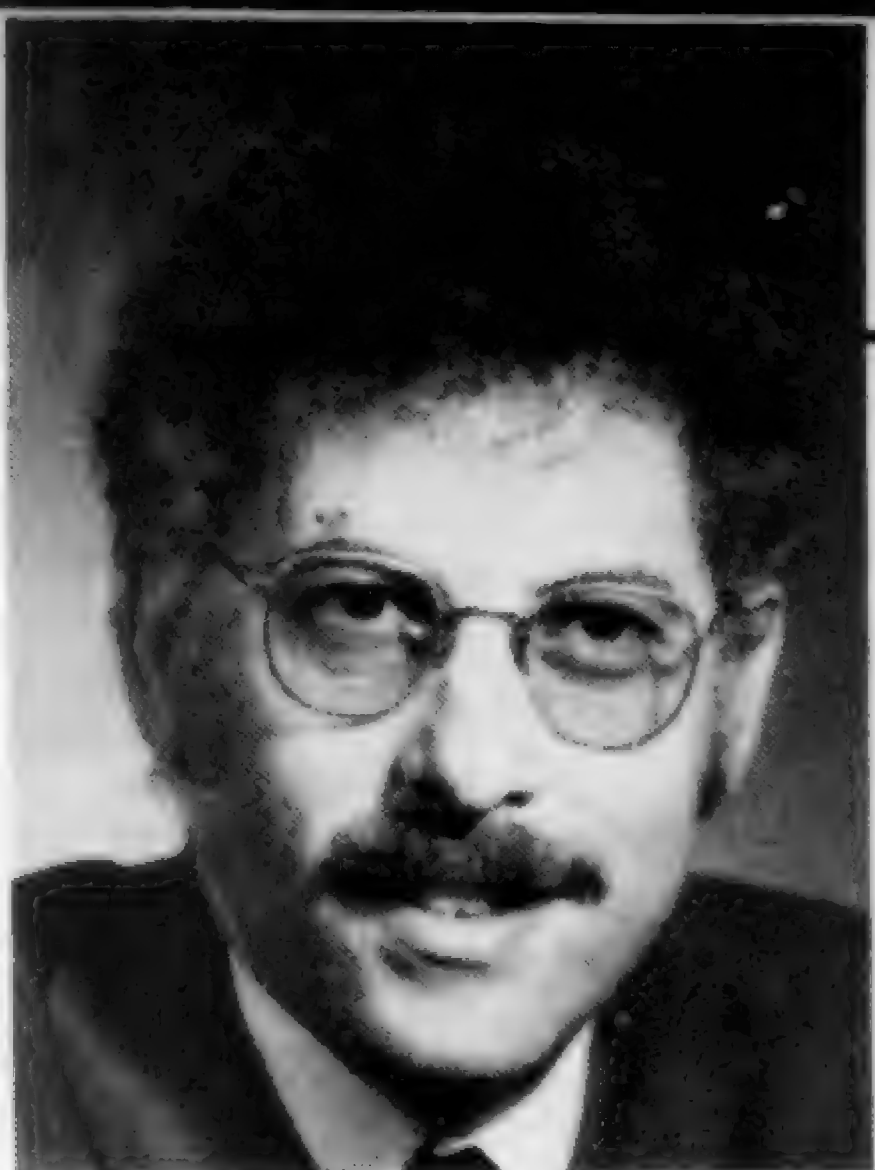
The key building block is "transfer"—the sequence from large to small scale imagery—to help students understand the meaning of scale, increase the variety of imagery and symbols learned, and build progressively broader perspectives. Different learning values accrue to each scale.

Whether budgets permit the purchase of much, or only limited imagery and maps, interspersing classroom/laboratory work with field experiences at the earliest possible stage is more productive than classroom sessions alone. Ground truth field studies are mandatory for optimal skill development and cognitive learning about the very real world the students live in and help use, and speed up the learning process, enhance retention and increase interest in related studies.

On the opposite page are notes on two new textbooks and others of value to an educator or a library.



A translucent paper planimeter scaled to a 1:24,000 map for aggregating measures on the size of a plot was devised by the Cartography and Remote Sensing Lab, Department of Geography, San Jose State University, California. The largest square covers one hectare of land.



OUTREACH

by Kerry M. Joëls
Chief, Education Division

One of our purposes in bringing you this magazine is to provide information and insight into modern scientific concepts. You, the teacher, can then take these concepts and mold them into ideas and activities for students. The problem is that students don't always see the need for studying science. Although aerospace topics have special appeal, many in our society, even many teachers, have a peculiar aversion to science. We keep it at arm's length. We do, however, love pseudo-science. Did you know that UFOs have already landed, that ESP bends spoons, and that if you were born under a certain sign, you will have a tendency to cry easily?

I'm not poking fun at these beliefs. They form a real part of society's perception of knowledge but some theories are really unprovable, pro or con. Several authors have begun to define and explain the relationship between pseudo-scientific thought and scientific thought. They point out that some ideas which were considered "way out" only 10 years ago are now con-

sidered part of our expanding search for scientific truth, like the search for extraterrestrial intelligence. Some competent scientists are looking at other phenomena once thought to be outside the realm of serious study.

What should a science teacher, or any teacher for that matter, do about such questions in the classroom? Is it right to use pseudo-science in the classroom? How will parents react to using ESP or UFOs for subject matter? Kids are fascinated by these things (so are adults), but are these topics really appropriate, and how should they be used?

As children we only had to touch the hot stove once or twice to know we didn't like it. Touching was the hard way to learn. Similarly, pseudo-science is the hard way to learn science, but if it is presented properly, the student may be able to distinguish somewhat between the two, and that's worth doing. Pseudo-science can be a motivation for learning science. For example, astrology can be a lead into astronomy, ESP into psychology. Argu-

ments about UFOs can lead into astronomy, biology, and even social studies.

Since discriminating between science and pseudo-science is difficult, and since the latter sometimes become the former, here are some guidelines gleaned from popular literature to help you tell the difference: Are respected scientists devoting valuable research time to the question? Do you find flaws in fact or in logic in a book? If you have some knowledge of a subject, and the author mistakes facts in that area, can you rely on the rest of the facts? Are the theories provable by simple test? (One author made a pyramid and spent time trying unsuccessfully to keep meat from spoiling.) Do you know a good amateur magician? What does he or she think about the experiments or demonstrations offered as "proof" of some power? What is the history of the author or "expert?"

Remember, scientists themselves can be as gullible as the rest of us when outside their specialties. They are trained to accept only those things that can be demonstrated by experiments repeated and confirmed by others. But they don't have time to check everything. So, perhaps we should teach with greater care the process of science—the constant questioning, the logic, the systems of review ("peer review") and such.

Remote Sensing: New Colorful Textbooks and Aids

Introduction to the Remote Sensing of the Environment, chapters by college professors of geography, edited by Benjamin F. Richardson, Jr., chairman, Department of Geography, Carroll College. Hard cover, 7½ by 9½ in., 496 pp., illus., index, 1978. Kendall/Hunt Publishing Co., 2460 Kerper Blvd., Dubuque, Iowa 52001, \$27.50. Laboratory Manual, \$10.95.

Remote Sensing and the Earth, Craig A. Brosius, science teacher; Janette C. Gervin, physicist, and James M. Ragusa, chief, Earth Resources Operations and Analysis, NASA Kennedy Space Center. Paperback, 8½ by 11 in., 472 pp., illus., 1977. Teaching guides after each chapter for secondary school usage. Published by the School Board of Brevard County, Instructional Services Division, Project Remote Sensing, 1274 S. Florida Ave., Rockledge, Florida 32955, \$9.74.

Everyone's Space Handbook, A Photo/Imagery Source Manual by Dick Kroeck, an engineer managing the data operations of the Airborne Instrumentation Research Project, NASA Ames Research Center.

Paperback, 5½ by 8½ in., 175 pp., illus., 1976. Nearly half the book is given to data on 118 sources of aerial and spacecraft images, usually low priced. Also, he notes that some 3,000 county offices of the U.S. Department of Agriculture have access to aerial photos of their counties. Published by Pilot Rock, Inc., Box ZZ, Arcata, California 95521. \$6 to December 1, 1978, \$9.95 thereafter.

RSEMS (Remote Sensing of the Electro-Magnetic Spectrum), a monthly. Articles on interpretation instruction can be modified for elementary and secondary levels. From Donald Rundquist, Department of Geography-Geology University of Nebraska, Omaha, Nebraska 68101, \$3 yearly to individuals.

Journal of Geography, eight/year. Articles frequently describe field trips. Subscribers automatically become members of the National Council for Geographic Education, University of Houston, Houston, Texas 77004. Inquire about schedule of dues.

A Practical Guide to the Use of Space and Aerial Photography in the Elementary and Secondary Classroom, Donna B. Hankins. Paperback, 8½ by 11 in., 19 pp. of text, 18 slides and pockets for two local views to be secured independently. 1976. Pilot Rock, Inc., Box ZZ, Arcata, California 95521, \$13.00.

Geological Remote Sensing from Space, F. B. Henderson III, G. A. Swann, Eds. Paperback, 8½ by 11 in., 60 pp., diagrams. Technical. Limited number of copies free from The Geosat Committee, Inc., 690 Market St., San Francisco, California 94104.

Mission to Earth: Landsat Views the World, by Nicholas M. Short, Paul D. Lowman, Jr., Stanley C. Freden, William A. Finch, Jr. Hard cover, 10½ by 14 in., 459 pp., glossary, index. An atlas of 400 spectacular color views of worldwide sites, with geologic, geographical, environmental data in captions; description of Landsat operation. NASA SP-360, 1976, Government Printing Office, Washington, DC 20402, Stock No. 033-000-00659-4, \$14.

1903-1905

Slow official recognition of the mastery of flight; 20 years later, an undercurrent of pessimism. Students may compare the beginnings of aviation with the first 20 years of the mastery of space, 1958-1978.

by Charles H. Gibbs-Smith
Lindbergh Professor, NASM

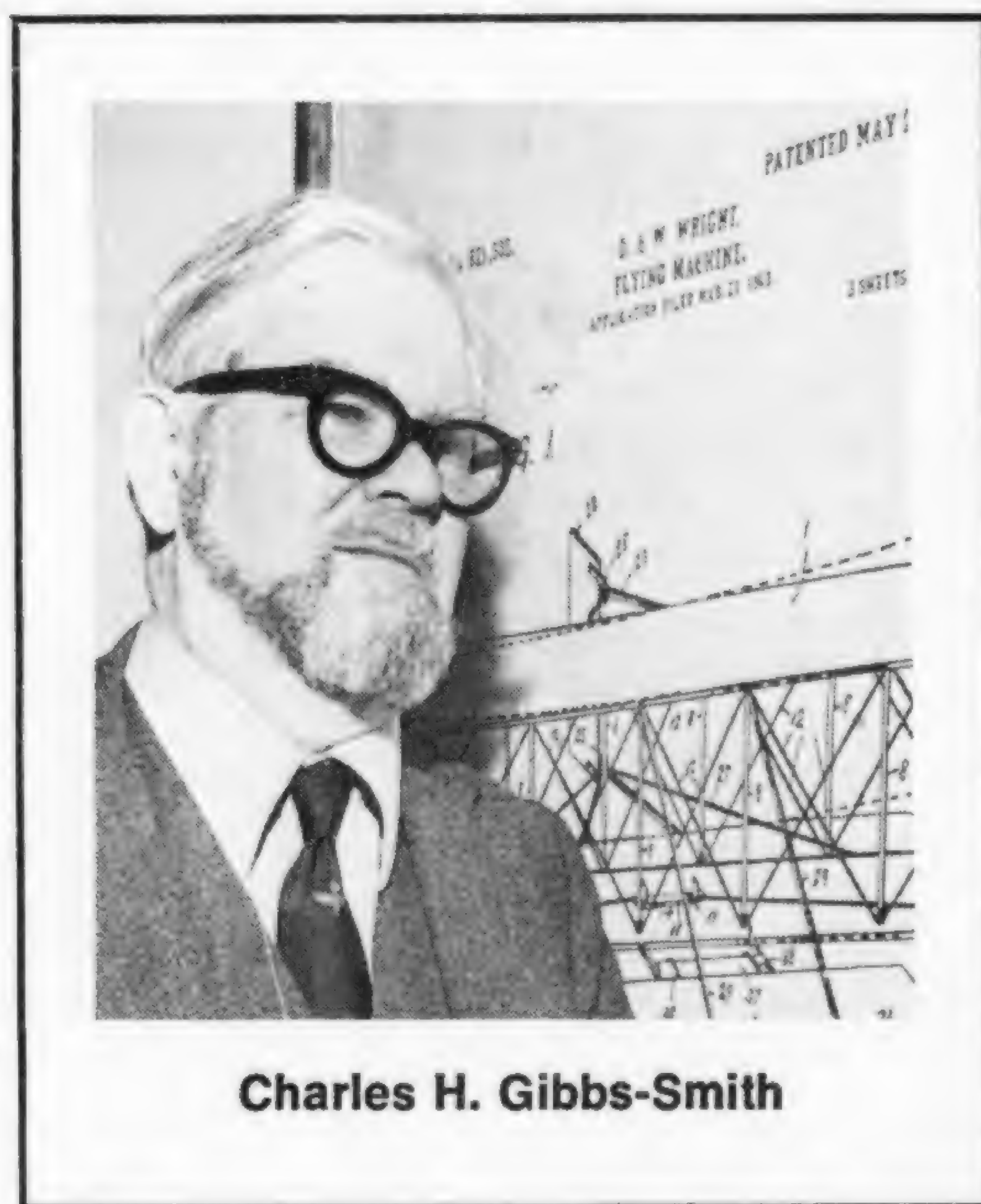
*The following is from The Wright Brothers by Mr. Gibbs-Smith, published by the Science Museum, London.**

Although the four brief flights of December 17, 1903 have naturally invested the Wrights' first Flyer with the greatest fame, their Flyer III of 1905—seldom dealt with in aviation histories—should stand equally with it; for the 1905 machine was the first practical powered aeroplane of history.

It was of the same general arrangement as the others, but noticeable differences appeared in the placing of the elevator farther forward and the rudder farther back to improve longitudinal control . . . Its speed was approximately 35 m.p.h. Like all the Wright aircraft, it was built inherently unstable and had to be "flown" all the time by the pilot.

The 1905 season . . . lasted from June 23 to October 16, over 40 flights being made.

But now the Wrights were concerned with reliability and endurance: they were airborne this season for just over 3 hours. In September, the trouble they were having in tight turns was diagnosed as a tendency of the lowered



Charles H. Gibbs-Smith

wings to slow up and stall; and the cure seen to be in putting down the nose to gain speed whilst turning. It was in seeking this cause and cure that the brothers took the important step of unlinking the warp and rudder controls, and providing for their separate, or combined, operation in any desired degree.

With this Flyer now perfected, the Wrights made many excellent flights . . . and—on October 5th—their record of 38 min. 3 sec., during which they covered over 24 miles.

The description of this machine as the world's first practical powered

aeroplane is justified by the sturdiness of its structure, which withstood constant take-offs and landings; its ability to bank, turn, circle and perform figures of eight; and its reliability in remaining airborne (with no trouble) for over half an hour. It is now preserved in a specially built hall in Carillon Park at Dayton (Ohio).

It was in 1905 that the Wrights first offered their invention to the U.S. and British governments. In January, on the experience they had had with the Flyer II, an offer was made to the U.S. War Department, which was refused outright without even an attempt at investigation—"a flat turn down," as the exasperated Wilbur called it. They then offered it to the British War Office. The British dilatoriness was as bad as the U.S. refusal; so, with persuasion from Chanute, the brothers again (in October, still of 1905) offered it to the U.S. War Department, with all the added confidence now provided by the performance of their Flyer III.

Again, it was turned down; again the War Department assumed the Wrights were asking for financial assistance—whereas they made it quite clear they were offering a finished product—and, this second time, the Department made one of the classic statements of aviation history: "the device must have been brought to the stage of practical operation without expense to the United States."

* Order from Pendragon House, Inc., 2595 E. Bayshore Rd., Palo Alto, California 94303; 36 pp., illus., biblio. \$3.00.



Another "1903 Flyer"

by Ben Owen
Project Schoolflight
Experimental Aircraft Association

At Blackhawk Technical Institute, a public post-graduate school in Janesville, Wisconsin, aircraft mechanic students have been part of a team building a reproduction of the Wrights' first Flyer. They used historic materials and processes, even to cutting and steam-bending their own ash wood (shop view, left). Although its engine

1923

The Prospects for Aviation

by Tim Wooldridge
Assistant Curator, Aeronautics, NASM

In 1923, a superficial review of the year's events would have given the impression of unprecedented accomplishment and unlimited promise for the future of aviation in the U.S. It was a year of outstanding technical achievements in the design and construction of aircraft, and increasing evidence of the airplane "being put to work."

The story of superior technical accomplishment is largely reflected by the multitude of aircraft performance records captured by the U.S. Typical of these are the world's endurance record of 39 hrs. 4 min. 34 sec. without refueling, established by Lts. Macready and Kelly, U.S.A.S., in an Army Fokker T-2; and the world's 3 km-course speed record of 266.59 mph flown by Lt. Al Williams, U.S.N., in a Curtiss-Navy Racer. The close of 1923 saw 33 out of 42 world records credited to American pilots in aircraft and with engines designed and constructed by the American aircraft industry.

Other noteworthy technical accomplishments included the successful operation of the airship, USS Shenandoah, an event which marked the establishment of the rigid airship industry in the U.S.; the wonderful night flying performance of the Air Mail Service; the demonstration of the possibility of a 30-hour air mail service between New York and San Francisco; the development of aircraft such as the Curtiss racers and the Douglas DT series torpedo planes, which led to the Douglas World Cruisers; and the development and refinement of such

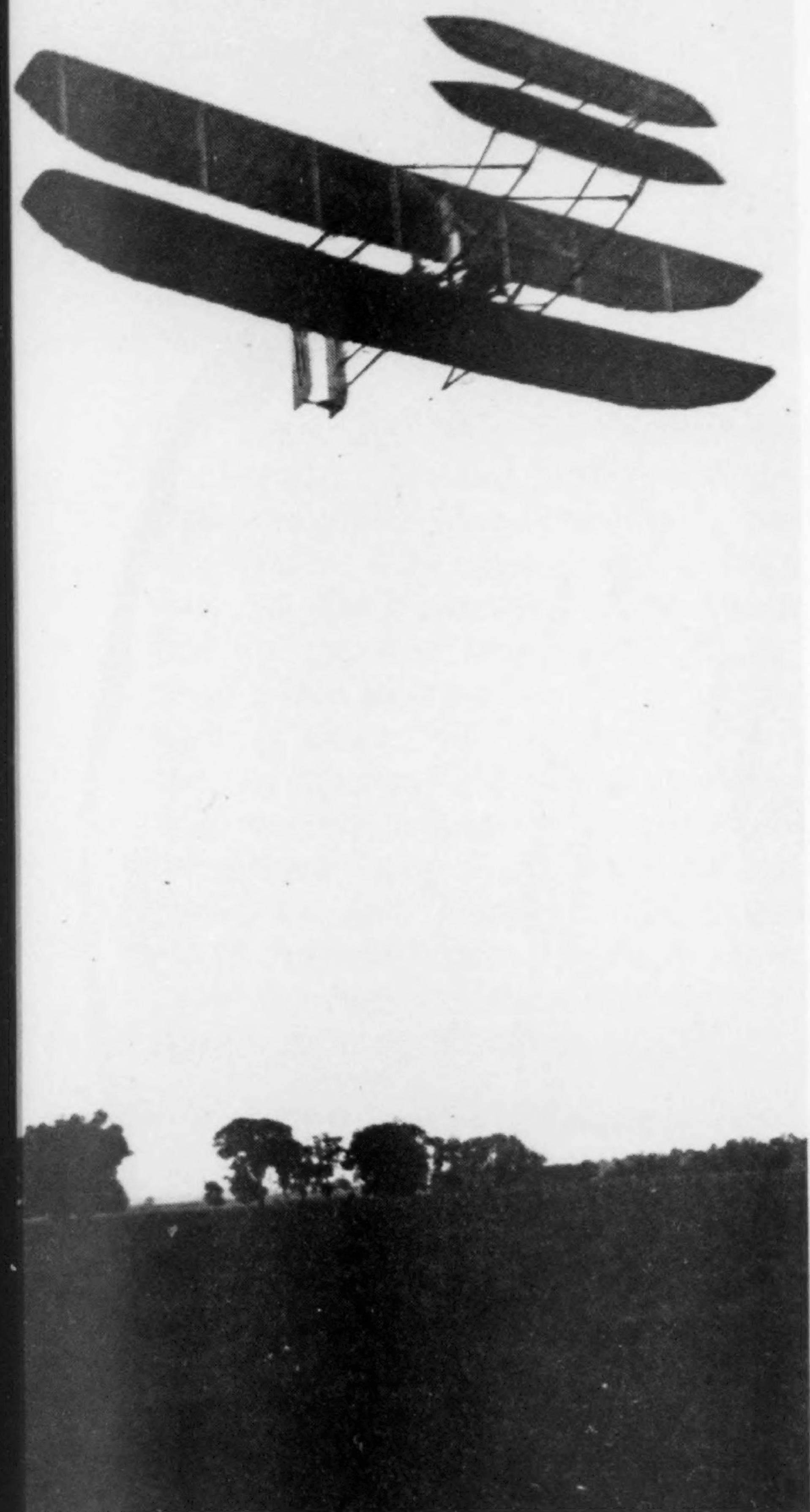
engines as the Packard Model 1A-1500 and Curtiss D-12.

The airplane was put to work in 1923, proving itself as an economic, efficient means of transporting passengers, mail and freight. Aerial application of insecticides proved to be economical and safe for the pilot. Aerial photography and skywriting became profitable ventures, while flying activity recorded by fixed-base operators increased during 1923. Duration and number of flights, distance flown, and numbers of passengers carried exceeded those of 1922.

All in all, the statistics for civil aviation were upbeat and suggested great promise for the future of aviation in the U.S.

Despite all this, there was an undercurrent of pessimism and doubt among knowledgeable citizens as to the future of our aircraft industry. We led in engineering and design, but trailed the world in production volume, and in the application of aircraft to aerial transportation. Government orders for military aircraft had steadily decreased, with a resultant stagnation of the commercial aircraft industry. Eighty percent of our military aircraft had been produced in World War I (1914-1918), had become obsolescent and unsafe to fly. There was a rising toll of deaths and injuries in the country due to unregulated flying.

Despite these signs of neglect, it would not be for another three years that the Air Commerce Act of 1926 would be signed by President Calvin Coolidge, and the foundations laid for progressive aviation programs in the U.S.



Wilbur and Orville Wright's Flyer of 1905, "the first practical powered airplane," according to Professor Gibbs-Smith. The sustained altitude it achieved is evident in the photograph above. It was not until 1908 that U.S. officials finally acknowledged the reality of flight, and the War Department decided to purchase a Wright Flyer.

from the E.A.A.'s "Project Schoolflight"

runs, the craft will never be flown, but will become a permanent exhibit at the Air Museum of the Experimental Aircraft Association (E.A.A.) in Franklin, Wisconsin.

The work is part of the E.A.A.'s "Project Schoolflight" program in which more than 260 volunteers are going to schools to get them interested in starting an Aviation Education class, or in building (or rebuilding) aircraft. After certification, many of these craft

are actually flown. Every year at the E.A.A. convention in Oshkosh* there is a week-long, three-credit session on how to set up such a program. Five years ago we knew of only 15 school-built airplanes. At this time we know of 260 projects initiated and more than 120 completions. More than 5,000 stu-

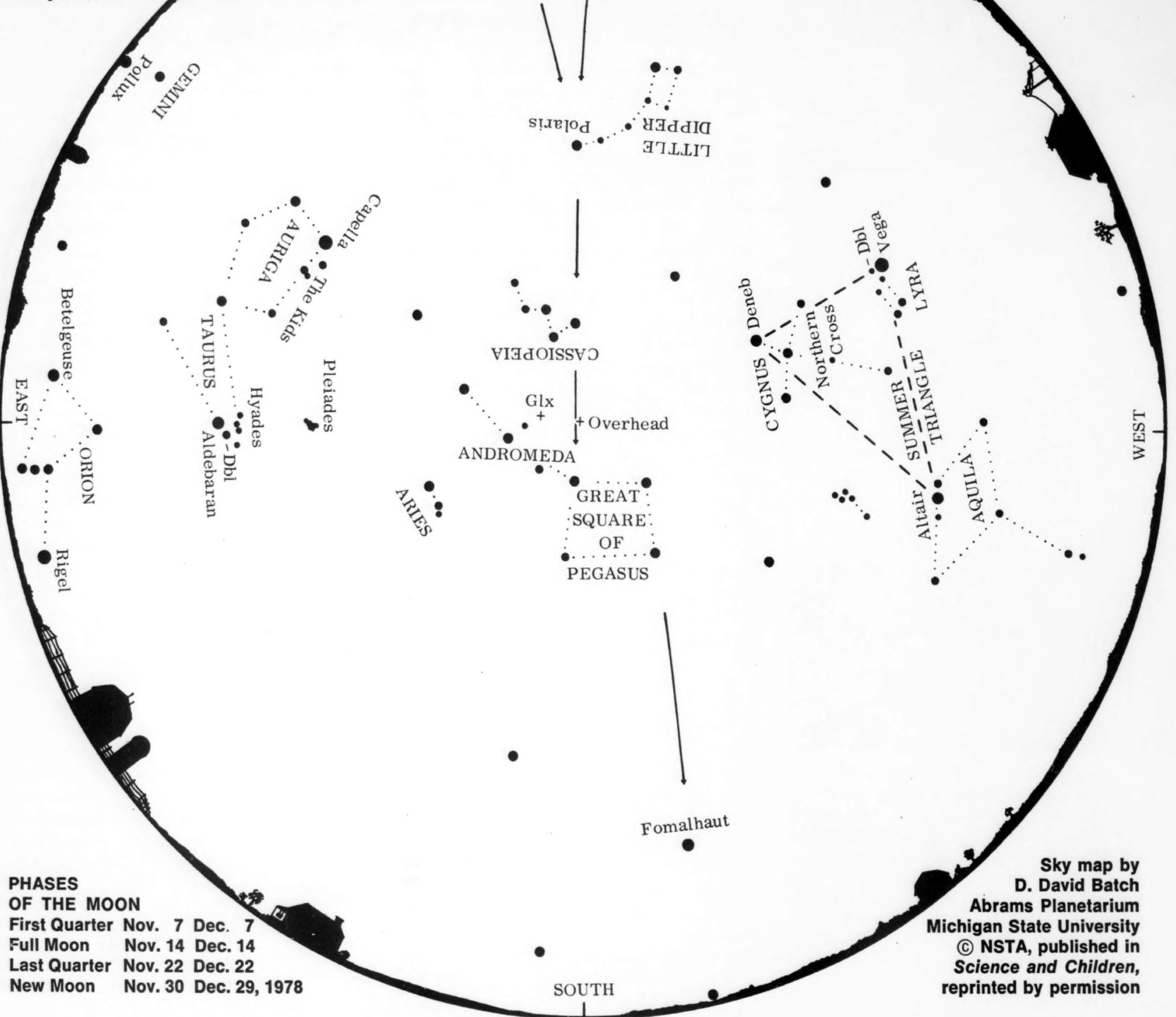
* More than 400,000 people attended the E.A.A.'s Oshkosh Fly-In last August, and 5,000 aircraft were often on the field.

dents have had or are having the opportunity to do realistic work on an airplane. The program has been an excellent motivational tool for young people, enabling them to relate their other academic subjects to problems involved in aircraft design and construction.

For a list of schools and colleges in the program, write to me at the Experimental Aircraft Association, P.O. Box 229, Hales Corners, Wisconsin 53130.

November Sky

HOW TO USE THIS STAR MAP
This disk represents the sky as it appears in late November at 9:00 p.m. or early December at 8:00 p.m. Line up map in the direction you are facing. The center of the map is the point over your head.



PHASES OF THE MOON
First Quarter Nov. 7 Dec. 7
Full Moon Nov. 14 Dec. 14
Last Quarter Nov. 22 Dec. 22
New Moon Nov. 30 Dec. 29, 1978

Sky map by
D. David Batch
Abrams Planetarium
Michigan State University
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Science and Children,
reprinted by permission

by **Dennis L. Mammana**
Staff Astronomer
Flandrau Planetarium, Tucson, Arizona

As autumn stars drift slowly out of view in the west, several new winter star patterns become visible in the east.

Very low in the southeastern sky, Orion the mighty Hunter is seen stepping over the horizon. His most prominent feature is the trio of stars that form a nearly straight line. They mark the famous "Belt of Orion." Also within the boundary of Orion lies one of the most beautiful and easily visible celestial objects—the Great Orion Nebula. A giant cloud of gas and dust where stars and possibly planets are con-

stantly forming, this stellar incubator is plainly visible even to the unaided eye as a hazy patch of light.

The Belt stars can also be used to find Taurus the Bull. Follow the line of stars to the northwest. You will soon intersect the reddish star Aldebaran, the fiery red eye of Taurus the Bull. Above this star and to the west is the Pleiades star cluster. Look at this group with a pair of binoculars—you will be amazed at the numbers of stars that are visible to the unaided eye.

Nearly overhead during this time of year is the Great Square of Pegasus. Off to the northeast of the Square is Andromeda.

Within Andromeda lies another hazy patch of light—the Andromeda Galaxy. Virtually a duplicate of the Milky Way, this galaxy is two million light years away. That means that the light you see from this object started on its journey through space two million years ago.

Still remaining in the west is the Summer Triangle consisting of Cygnus the Swan, Lyra the Harp, and Aquila the Eagle. Watch Cygnus as the Christmas season approaches. Also called the Northern Cross, Cygnus appears to stand upright on the western horizon at this time of year, providing a gentle reminder of the holiday season.



Artists' concepts:
L.: Lunar Orbiter 1.
R.: Apollo 8 with
cutaway section
showing astronaut
observing surface.



10th Anniversary—APOLLO 8

Ten years ago this December, men first ventured beyond Earth's protective radiation shield (Van Allen Belts), traveled farther than anyone before (more than 386,000 kilometers, to the Moon), and for the first time saw Earth as a small globe beyond the rim of another body in space. Any classroom observance of the Apollo 8 anniversary could well include tribute to 19 preceding, unmanned lunar flights—the Rangers, Surveyors and Orbiters. These gave NASA the information and flight experience on which to risk men's lives in the Apollo orbit and landing missions.

by Gregory P. Kennedy
Astronautics Department, NASM

"Goodby, good night. Merry Christmas. God bless all of you, all of you on the good Earth." With those words, astronaut Frank Borman ended the telecast from Apollo 8 as it orbited the Moon on Christmas Eve, 1968.

The mission had begun three days earlier, at 7:51 a.m. EST on 21 December 1968. Creating a brilliant spectacle,

the 111-meter tall Saturn V launch vehicle roared to life. Slowly at first, gradually increasing its speed, the Saturn rose into the early morning sky over Florida. This was the third Saturn V launched and the first to carry a manned spacecraft. During 11½ minutes of powered flight, the Saturn discarded two stages, burned 2.6 million kilograms of propellants, and thrust the Apollo 8 Command Service Module (CSM) into a 189-kilometer high orbit. The crew of Frank Borman, James Lovell and William Anders checked spacecraft systems, then ignited the Saturn's third stage motor for the second time. After a five-minute burn, the spacecraft was moving at nearly 40,000 kilometers per hour.

The 10-meter long CSM coasted through space until 24 December. Then, at 4:49 a.m., it lost contact with Earth as it curved behind the Moon. At 4:59 a.m., the 91,225-newton thrust engine in the Service Module was fired for just over four minutes, inserting the CSM into lunar orbit.

Apollo 8 orbited the Moon 10 times. During the 20 hours they spent in lunar orbit, the crew photographed the Moon's surface with special attention to proposed landing sites.

Borman, Lovell and Anders made two television transmissions from lunar orbit, seen by millions of viewers back home on Earth. The crew described Earth as a "... grand oasis in the big vastness of space ..." and read from the Book of Genesis.

At 1:10 a.m., 25 December, the Service Module engine was fired again, boosting Apollo 8 into a course for Earth, at more than 9,700 kilometers per hour. Soon, Earth's gravitational pull accelerated it to nearly 40,000 kilometers/hour.

Just before reaching Earth's atmosphere, the Service Module was discarded. The Command Module turned around, blunt end forward, and began its fiery reentry, splashing down in the Pacific Ocean, 1,760 kilometers southwest of Hawaii. Man's first journey to the Moon was over.

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- ☐ Aerospace in particular
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LEVELS

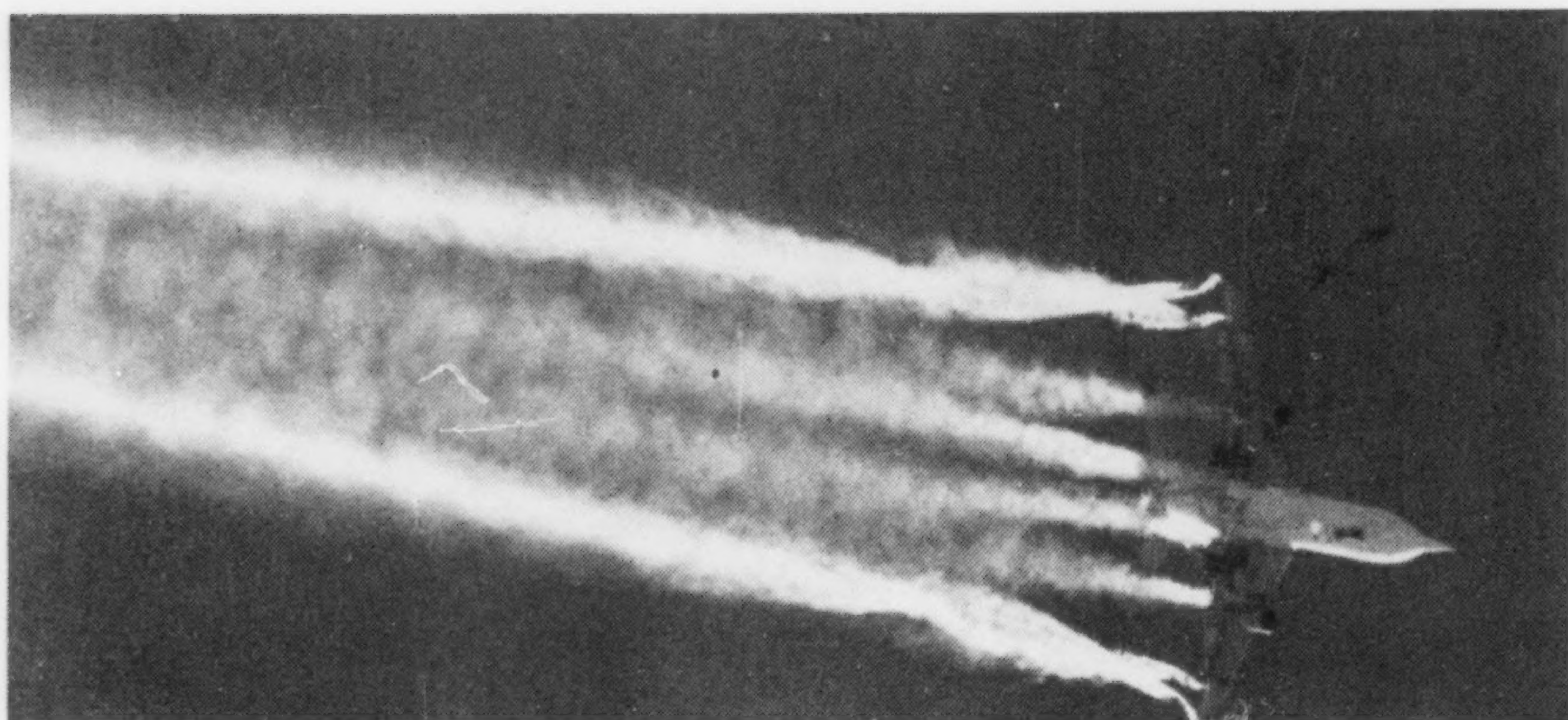
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THINK ALONG WITH THE AEROSPACE ENGINEERS

on how to cope with the aviation hazard of wake vortices



Top: Smoke generators make visible the air turbulence behind an L-1011 jumbo jet. All lifting areas roll off vortices, but the "horizontal tornadoes" near the wing tips are strongest, may trail for eight to ten miles in still air. They can roll or severely buffet a following aircraft. **Below:** Smoke reveals several revolutions of a vortex from the landing aircraft barely visible at lower left.

Invisible "horizontal tornadoes" trail behind an aircraft in flight and can pose a safety problem (see Page 5). Many researchers study aircraft configuration, hoping to minimize the development of vortices; or find ways to make vortices decay faster or to forecast their behavior so that following aircraft can simply avoid them whenever necessary.

The first approach can be self-defeating. Wingtip devices, fences, or other means to minimize the rollup of a vortex can reduce lift, or increase noise and buffeting, or cause any one of a number of other problems. Yet, who knows? With research, a great new approach may be discovered.

Let students think of vortex-tracking methods which are automatic, effective in all weather (day and night) and capable of quickly providing data to air traffic controllers. Smoke, which is used in basic research, would be called air pollution in a permanent system.

Researchers have tried non-visual methods, as the return of an acoustic pulse, or the Doppler shift of acoustic signals bounced off a vortex. Researchers do not seem to favor microwave and infrared detection, which in today's technology, return too little backscatter.

FAA's Walter Luffsey said one day at NASM, "If you know enough about the wind and how it affects vortices, you can take wind measurements and say whether or not vortices are going to be blown from a runway or dissipated in a certain amount of time." In tests, anemometers were set up around Chicago's O'Hare Field; readings were compared with vortex behavior in some 90,000 aircraft approaches sampled at several major airports. A predictive algorithm (computer software math model) was worked out. Now, a computer at O'Hare constantly compares averaged wind data with this algorithm, and transmits figures to a display panel in the control tower. Controllers see at a glance when it may be safe to reduce the standard separation time between arrivals.

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